THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 56 Thursday, March 4, 1937 No. 1072

PUBLISHED WEEKLY

Subscription Terms : 15s. per annum.
Foreign and Colonial : 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address : "Zacatecas, Rand, London."
Telephone : Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT : 1935-36

H. Winterton, "Moorlands," Milngavie, Dumbartonshire.

LIST OF SECRETARIES—

General Secretary : T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office : 49, Wellington Street, London, W.C.2.

Birmingham, Coventry and West Midlands : A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham.

East Midlands : B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.

Lancashire : J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.

London : H. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.

Middlesbrough : D. R. Kinnell, Chas. P. Kinnell & Company, Limited, Vulcan Ironworks, Thornaby-on-Tees.

Newcastle-upon-Tyne : W. Scott, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.

Scottish : J. Bell, 60, St. Enoch Square, Glasgow.

Sheffield : T. R. Walker, B.A., "The Priory," Oughtibridge, near Sheffield.

Wales and Monmouth : J. J. McClelland, 12, Clifton Place, Newport, Mon.

West Riding of Yorkshire : S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.

Bristol : A. Hares, Park Crescent, 648, Stapleton Road, Bristol.

Burnley : W. Haworth, 37, Westbourne Avenue, Burnley, Lancs.

East Anglian : J. L. Francis, 53, Cromer Road, Ipswich.

Falkirk : H. McNair, "Braewick," Larbert Road, Bonnybridge, Scotland.

Lincoln : E. R. Walter, M.Sc., The Technical College, Lincoln.

Preston : P. Leyland, 7, Ashley Terrace, Farington, Lancs.

The Institute of Vitreous Enamellers

President : Dr. J. W. Mellor, F.R.S., Sandon House, Regent Street, Stoke-on-Trent.

Chairman : W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.

Hon. Secretary : Miss E. Christine Elliot, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association

President : G. T. Lunt, "San Simeon," Newbridge Crescent, Wolverhampton.

Secretary : K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President : W. E. Clement, Morfa Foundry, New Dock, Llanelly.

Secretary : J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are :—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone : Central 1885. *Telegrams : CIRA*
The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone : 332

Contents

	PAGE
The Limited Company, Public and Private	185
The Statistical Position of the Foundry Industry	185
London Foundrymen's Visit to Belgium	186
Sheffield and Its Foundry Activities	186
Random Shots	186
Recent Improvements in Refractory Materials ...	187
Notched Bar Bend Tests	189
Desulphurisation in the Blast Furnaces	189
Quantity Production of Railway Steel Castings in Canada	190
Further Developments with Coal-Dust in Moulding Sands	192
Behaviour of Steel at High Temperatures	193
Crofts (Engineers), Limited	194
British Iron and Steel Federation : New Offices	195
Book Review	195
Vitreous Enamelling Section—	
Elements of Costing with Reference to Vitreous Enamelling	196
Mechanical Drying in Vitreous Enamelling ...	199
Metal Degressing	202
The Week's News in Brief	204
Trade Talk	204
Forthcoming Events	204
Raw Material Markets	206

The Limited Company, Public and Private

The limited company was an English invention, and has had a great deal to do with the building up of the structure of industry and trade that we know to-day. The public company serves the double purpose of making possible the participation of the public in providing industrial capital and of limiting their liability in case of failure, while in the private company only the latter advantage is secured. With a world-wide economic structure, a company may fail for causes quite beyond its control and quite unconnected with the integrity or ability of its management. As in so many other instances in this country, measures taken primarily for the protection of the public have been found advantageous enough to adopt even where the public is not concerned, as is illustrated by the formation of private companies, the regular establishment of which our periodical lists of company registrations give witness. In the iron and steel industry the original initiative was almost wholly due to private enterprise, and until comparatively recently many of them remained in private hands, connected in many cases with the founders in various parts of the country who began them. Many of these to-day are private companies, and between them and a public company there is very little difference. There are, we learn, 123,000 private companies registered in England, with an average capital of about £12,000. The number of public companies is much less, about 15,000, but their aggregate capital exceeds double that of the private companies, the average being about a quarter of a million pounds. To-day, over thirty private companies are registered for every public company, although the latter has on the average about 25 times as much capital. This is a tribute to the popularity of the private company, which has grown so remarkably in recent years. So much so is this the case that in many registrations scarcely any capital is concerned at all, and the advantages must be real to offset the formalities concerned. To-day, business development follows the course first of all of a private company, which, after proving its success, is floated as a public company, in the shares of which the general public can invest.

The Statistical Position of the Foundry Industry

In 1929 the advertisement pages of this journal used to carry a slogan that the buying capacity of the British foundry industry was £26,000,000 per annum. This figure was based on an estimate prepared by us, and was derived from the very meagre figures then available. With the passage of time, detailed statistics are forthcoming which very materially strengthen the assertion we then made. The latest contribution is the Report of the Import Duties Act Inquiry (1934), Part II (price 4s. 6d. from H.M. Stationery Office), which *inter alia* covers the iron and steel foundry industry. From this we have reproduced Table I, which gives a general summary :—

Particulars.	Unit.	1934.	1933.	1930.
Value of products (gross output)	£'000	33,988	27,624	29,447
Cost of materials used	do.	13,721	10,959	12,234
Amount paid for work given out	do.	135	110	165
Average number of persons employed ..	No.	99,574	86,639	91,461
Net output per person employed ..	£	202	191	186

It will be seen that in 1930 the buying capacity of the iron and steel foundry industry, exclusive of new plant and of all the expensive raw material of the non-ferrous sections, was of the order of £12,000,000. Thus we are satisfied that our estimate was reasonably correct. The report, moreover, confirms the figures set out in Mr. Whittle's article on the vitreous enamelling industry, which appeared in our Annual Review Number.

The Report discloses many other very interesting figures, such as the production of malleable iron castings in 1933 and 1934, which were 35,000 tons and 67,300 tons respectively. It shows, moreover, that there was a modicum of price cutting in those years, as the value for the lesser quantity was £1,285,000, or £36.7 per ton, whilst for 1934 the value was £1,803,000, or £26.8 per ton. These figures do not include 1,400 (*circa*) tons returned on other schedules.

The steel foundry industry, for which the statistics are not yet perfect, was down in 1933 to a castings production of 20,800 tons, which was valued at £593,000 (or £28 10s. per ton). It rose to 29,500 tons in 1934, the value being £913,000, or nearly £31 per ton.

One of the most interesting aspects of the foundry trade is its production in relation to imports. For cast-iron pipes the market is retained to the extent of over 99 per cent. For stoves, grates and ranges for domestic cooking

(*Concluded on page* 186.)

Sheffield and Its Foundry Activities

ENCOURAGING TRADE PROSPECTS

At the annual dinner of the Sheffield Branch of the Institute of British Foundrymen, held on February 18, MR. W. J. REES (President of the Refractories Association of Great Britain) proposed the toast of the Institute of British Foundrymen and the Sheffield Branch. He said that the foundry industry was definitely complementary to the refractories industry, and any prosperity in the foundry industry was reflected in the refractories trade. One could say much concerning the manifold activities of the Institute, of its succession of Presidents, or of the genius of the Institute's secretary, and one had only to read the annual review number of THE FOUNDRY TRADE JOURNAL to get a real insight into what the foundry industry meant, not only to this country but to the world.

British Research Activities

One of the most important activities of the Institute, and one that was going to benefit not only the Institute itself, but the foundry industry of the country, and indeed of the world, was that relating to research, in which Mr. Roxburgh himself had taken so great a part. There still seemed to be an idea that in this country they were a little diffident in their prosecution of research, but this was by no means true. The Department of Scientific and Industrial Research in this country had no counterpart elsewhere in the world, although perhaps the extent of research in this country was not on such a large scale as it was, say, in Russia, where, he believed, 1 per cent. of the national income was at present being spent on the development of research. Nevertheless, in England, as a nation, they were active in research, and through the Department of Scientific and Industrial Research that research was well organised and exceedingly fruitful, as could be seen from the recently issued report of the Department. The Institute of British Foundrymen was doing its full share in the matter of research.

So far as the Sheffield Branch of the Institute was concerned, it had had a number of distinguished Presidents. For some years they had had for their honorary secretary a man who was not only diplomatic, but indefatigable in his work, both for the Branch and the Institute as a whole. A particularly noteworthy feature was the continued interest which all Past-Branch Presidents continued to show in the activities and well-being of the Branch. In Mr. Roxburgh they had a worthy member of their line of Branch-Presidents. The toast was accompanied by musical honours for Mr. Roxburgh, whose name was coupled with it.

Shortage of Labour

In reply, MR. J. ROXBURGH (Branch-President) spoke of the importance of research, and said that foundrymen appreciated that their industry required the services of the scientist. The Institute was comparatively young, but the industry it represented dated back to the very beginnings of civilisation, and members of the Institute were very proud of their industry.

As President of the Sheffield Branch he had been delighted at the attendances at the Branch lectures, and had been impressed by the enthusiasm displayed. He would like to take the opportunity of thanking the members for their support. One of the meetings was devoted to a short Paper competition, and it was rather significant that the Paper which provoked the most discussion was one on apprentice training. He said there was no doubt that the foundry industry was suffering from a shortage of skilled labour and of executives, which should be taken as a warning and the necessary steps made whereby the matter would be put right for the future. The year 1936 had been a record year in many respects, but he believed that in the foundry industry they could look forward to having a still better trade in 1937. Mr. Roxburgh said he would not like the occasion to pass without expressing his high appreciation of the work of the Sheffield Branch hon. secretary, Mr. T. R. Walker, and the excellent help given by the Senior and Junior Vice-Presidents (Mr. J. B. Allan and Prof. J. H. Andrew), and the members of the Council, who had all so excellently supported him during his year of office.

Meeting New Market Demands

MR. C. W. BIGG (Senior Vice-President of the Institute), proposing the toast of "The City and Commerce of Sheffield," said it was essential that the Institute should be strongly represented in Sheffield, because in Sheffield the foundry industry was so important, and similarly Sheffield was important to that industry. That mutual interest was strongly evidenced two years ago at a successful annual conference, when the civic and commercial heads of the city combined to show their appreciation of the Institute and the industry. No industry more than the foundry industry derived so much profit and pleasure in the recovery of Sheffield from a period of depression, and none was more wishful for a continuance and expansion of the city's present prosperity. In the heavier departments of the steel and foundry industries a very bad time had been experienced. He believed that until quite recently the only sections employed at anything like capacity were those engaged in what used to be called the luxury trades. Times had since changed, and the luxuries of yesterday were the necessities of to-day. The comparison between what was now demanded as necessities by a man to-day and the requirements of his father was amazing. Industrialists should legislate so as to ensure the permanency of that demand. Their home market had developed potentialities, and the so-called "saturation points" had been passed long ago. The industry was now looking forward to a change in the international situation which would pave the way for an improvement in export trade. The heavier industries were already feeling the benefit of increased confidence; old plant was being scrapped and new plant being installed, which was very satisfactory for Sheffield and the foundry trade, whose immediate prospects were bright.

The Institute existed primarily to promote efficiency in its own industry—fostered by education and research. Sheffield was to be congratulated on the facilities she had for promoting both those important contributions to industrial progress, and the Institute was honoured to be associated with Sheffield University in what could be justly claimed to be a most important step in industrial education.

Replying to the toast, THE LORD MAYOR OF SHEFFIELD (Councillor MRS. A. E. Longden) remarked that the foundry trade might well be referred to as the basis of the steel industry of Sheffield, and she saw no reason why the improvement in Sheffield trade should be merely of short duration.

The toast of the guests was offered by MR. J. B. ALLAN (Senior Vice-President of the Sheffield Branch), and responded to by MR. J. W. GARDOM.

London Foundrymen's Visit to Belgium

Through the courtesy of the Nouvelles Fonderies Mecaniques Scheppers Podevyn, of Antwerp, members interested in visiting a really modern non-ferrous foundry have had that opportunity afforded them as an alternative to inspecting the roll and chilled iron foundry on the morning of arrival.

Random Shots

This column is the Editor's apology for being elsewhere in his JOURNAL so very technical. The comic relief, as it were, to heavy technology, but even in those austere pages there lies a wealth of fun! For the incorrigible artist on blotting paper at committee meetings there are endless possibilities in the many Batemanesque line drawings which appear week by week. For those weary industrialists who chase up and down the country in trains day by day, there are excellent opportunities for noughts and crosses on the graphs which scientists love to produce. Rest your tired brains by looking at your technical journals, which of course you always carry about in large numbers, with different eyes! On page 154 of the February 18 issue, for instance, there are all ready set out for your amusement three lovely games of "dots and squares." Who could resist them? If you are travelling alone, get the man next to you to play with you. If he be a grey iron block you are certain to win. On the other hand if he looks like a potential customer, let him win. Discretion has ever been the better part of valour. * * *

Wouldn't it be a grand idea if the Branches, for their annual dinners, would depart from convention so far as to make up their menus from the little-known delicacies of the districts which they represent? Mr. Makemson and the President, who for their sins must attend many of these functions, would at least be grateful. With a menu so unorthodox what might not one begin to hope from the after-dinner speech! What a feast for the gods Loughborough could have put before their guests last Saturday—swans baked in a pie from Nottinghamshire, more pies from Melton Mowbray, shuttlebuns from Rutlandshire, and Leicester cheese! Imagine an East Anglian dinner consisting of little loaves stuffed with oysters from Colchester, raw cygnets from Norwich, Essex paigle (that's a good one, don't you think?) and Suffolk rusks.

Manchester would have to provide a tea as well as a dinner to include all the delectable dishes and cakes of Lancashire and Cheshire, but that shouldn't be difficult for such a generous people! Hot pots, Manchester puddings, Oldham pastries, Simnel cakes, Eccles cakes, Ormskirk brawn, and Cheshire cheese are perhaps only a few of them, but quite enough to be going on with in these days of Hay Diets.

"MARKSMAN."

The Statistical Position of the Foundry Industry

(*Concluded from page* 185.)

and heating, a similar condition obtains, except for those fired by liquid fuel; in this case between 14.1 and 16.4 per cent. of the market requirements are filled by imported material. The bath situation presents the least satisfactory position of all, as in 1933 British production covered only 81.7 per cent. of the home-market requirements, a position somewhat ameliorated in 1934, when this figure was improved to 85.2. We were rather intrigued with a footnote in the Report relating to the bath situation, which reads:—"The figures for exports and imports for 1933 did not relate specifically to goods of cast iron. For 1934 they are exclusively of *wrought* enamelled baths." The italics are ours.

The employment of youth in the iron and steel foundry presents features of interest. Excluding female labour and the administrative, technical and clerical staff, there were in 1933 9,904 youths under eighteen out of a total of 84,808—a rather higher percentage than one would expect after listening to after-dinner speeches. The number of females employed is recorded as being 5,182 in 1934, of which 1,534 were under 18.

Finally, the Report records that the industry in 1934 bought 1,335,000 tons of pig-iron.

Recent Improvements in Refractory Materials*

By P. B. ROBINSON, M.Met.

A refractory must withstand a high temperature; it must withstand the desired working temperature of the furnace in which it is applied, also working conditions of pressure (if it forms part of an arch or a high wall), of abrasion by hot dusty gases, of chemical action by slag, of sudden thermal shocks, and of variations in atmosphere. There is no ideal universal refractory material, and many of the qualities included in the above definition are conflicting, for if one concentrates on obtaining one of these qualities in a brick, it may be to the detriment of some other. All materials have limitations in certain respects.

Fireclay is a good all-round material for use in a multitude of processes carried on at moderately high temperatures, but owing to its peculiar constitution it will not withstand load at high temperatures and is susceptible to slag attack. Alteration of the composition to enrich either the SiO_2 or Al_2O_3 brings on new complications. High SiO_2 and high Al_2O_3 bricks, although more refractory and more resistant to slag than fireclay, each have their own limits of application. Chrome should be an excellent refractory with a wide application, but so far a really strong brick has not been made from this material, and it fails badly under load at high temperatures. Magnesite is very refractory, but has a strong tendency to spall. Dolomite ought to be an excellent basic material; it is cheap, abundant, and has a high melting point, but so far has not been made into a stable, strong brick. Sillimanite has a good refractoriness, but is only feebly resistant to ferruginous slags, whilst carbon has possibilities, but it must not be used in contact with air. These limitations not only cause worry and increase costs, but definitely limit technique in certain industrial processes.

Possible Economies

From the users' point of view increased life of refractories is highly desirable, whether it be in the case of a steel ladle, which at present might last eight to twelve casts, or a blast-furnace lining which lasts for some years. Not only have replacement charges to be considered, but also loss of output and charges consequent on plant being laid idle. In the case of a blast furnace producing 2,000 tons of metal per week, a lining lasts, say, three years, and costs £10,000 in material and labour to replace. This is only a matter of less than a shilling per ton on the total output of the furnace, which is not really serious, but it also means the blast furnace being out of action for relining for four to five months every three years, or about 15 per cent. of its life, and represents a serious loss of output. In the cupola the cost of refractories per ton of metal is very small, but the loss of output in a small foundry becomes of importance when relining is necessary. Only in the coke-oven industry this does not seem to apply. The life of silica walls in coke ovens in this country is not yet known, but the walls of the first all-silica plant in England, which has now been operating twelve years, are as good as new, and there appears to be no reason why they should ever need rebuilding—the plant itself will become obsolete first.

Basic Roof Tests

In some cases materials are being used which are really unsuitable, either chemically or because they limit the temperature at which the furnace can be worked. The basic open hearth with its silica roof is a case in point. Chemically it is ridiculous to use a silica roof to a basic furnace, but at present there is no alternative. In a series of tests on the roof of a basic electric furnace reported in "Stahl und Eisen," September, 1936, results were given of the six basic bricks most likely to succeed. All failed in some respect and the conclusion arrived at was that silica was at present the most satisfactory material for use in this position.

The refractory limitations of silica slowed down steel production in both acid and basic processes, for the temperature in the open hearth furnace is limited by the temperature at which the roof begins to drip. Steelmakers demand still higher melting temperatures to accelerate production, but these cannot be obtained in furnaces built with existing materials.

Chief among the difficulties to be faced is the lack of knowledge of fundamentals, which until a few years ago was perhaps greater in this industry than in any other. Knowledge is growing, however, largely due to the research institutions such as the British Refractories Research Association, the Geophysical Laboratory, Carnegie Institution of Washington, and the Kaiser-Wilhelm Institute, Berlin.

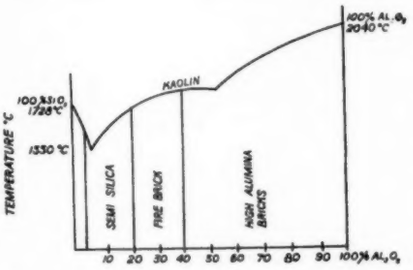


FIG. 1.—DIAGRAM SHOWING THE SOFTENING POINT OF MIXTURES OF SiO_2 AND Al_2O_3.

Small Margin Available

Other constructional materials are used under conditions which are extremely simple when compared with refractories. Metals, for instance, are used normally at temperatures much below their melting point where reaction rates between the different phases are so slow as to be negligible. With refractories this is not the case. They are frequently used at temperatures near their melting point, and complete physical and chemical equilibrium is rarely reached in manufacture, and if it is, it tends to be upset by slag penetration.

Chemical and Physical Properties of Fireclay

Fig. 1 shows the behaviour of mixtures of pure SiO_2 and pure Al_2O_3 at high temperatures. Pure SiO_2 is supposed to have a melting point of 1,728 deg. C. and pure Al_2O_3 of 2,040 deg. C. When Al_2O_3 is added to SiO_2 the melting point of the mixture drops and reaches a minimum of about 1,550 deg. C. when the composition is about 90 per cent. SiO_2 and 10 per cent. Al_2O_3. With increasing proportions of Al_2O_3 the softening temperature rises again to the melting point of pure Al_2O_3.

The essential constituent of clay can be considered as kaolinite, $Al_2O_3.2SiO_2.2H_2O$. If there were such a thing as a "pure clay" it would have this composition (when calcined, 55 per cent. SiO_2 and 45 per cent. Al_2O_3). In practice the material always contains impurities; the chief of these is free SiO_2. If a clay contains more than 55 per cent. SiO_2 the excess will be mainly silica in the form of quartz. The effect of this on the softening point is in general to lower it. High alumina, on the other hand, raises the softening point, and this is one of the chief reasons for the success of the high alumina brick.

Influence of Impurities

There are, however, other impurities, and each has its effect in lowering the softening point of the pure clay substance, kaolin. For instance, some felspars melt at 1,200 deg. C. and 10 per cent. felspar can lower the softening point by about 80 deg., 5 per cent. of mica can lower the softening point by about 20 deg. and so on.

Not only do these impurities act on the clay substance in this way, but when more than one is present there is a cumulative effect which greatly exceeds a mere additive effect of the fluxes. An ordinary fireclay may contain six or seven different mineral impurities and thus the softening points can be so much lower than appears likely from a chemical analysis. The reactions which result in the formation of mixtures or eutectics of low melting point are generally slow, but the reaction rate is influenced by many variables. One of these is the grain size and intimacy of mixing of the components; another is pressure.

No True Melting Point

When the clay is burned in the brickmaking process these mixed minerals react, forming melts in the body of the clay. If the burning temperature is right, these liquids, by dissolving more and more solid material, remain highly viscous. As the burning progresses so also does the formation of this highly viscous melt. Pores become filled and the volume of the clay diminishes. When the brick is cooled the material, instead of being crystalline, partakes rather of the nature of super-cooled liquid or a glass. On reheating, at any temperature above 1,000 deg. C., these glass-like properties show themselves and the brick behaves as a plastic body. One such property is that it has no true "melting point," but softens over a range of temperature which can be varied by such external conditions as rate of heating pressure, etc.

A firebrick may have its softening point lowered very considerably by pressure, as much as 300 deg. C. when heated in a laboratory under test conditions, and even more than this when the time is lengthened. This explains the distortion so often occurring in the lower courses of coke-oven walls built of clay-bonded semi-silica material.

Influence of Iron

The case of iron is rather difficult, for it can exist as a constituent of the felspar and micas or as ferrous carbonate or as sulphides. In the weathered clay this may be altered in part to $FeSO_4$, which tends to dissolve in, and be washed away by rain, so that the iron content of a clay may be reduced by weathering. The subsequent behaviour of iron in the burned firebrick depends largely on the conditions of burning. If in the burning operation it has been converted into Fe_2O_3 it may be more harmful than as FeO, when it has probably formed a familiar black spot of ferrous silicate which melts at 1,100 deg. C. In themselves, if not too abundant, these black spots do little damage, but there are certain types of work in which iron in quantity in any form can be definitely harmful.

In particular is this so in the stack of a blast furnace. Gases can penetrate into the pores of a firebrick, and when CO in the blast-furnace gas at a temperature of about 400 deg. C. penetrates the bricks of the lining and comes into contact with iron compounds, a reaction occurs resulting in deposition of carbon in the laminations and pores of the brick. The bricks tend to swell and disintegrate, and have been known to crumble completely away. There is evidence that ferric iron is more likely to react in this way than is

c 2

* Paper presented at a joint meeting of the Northern Section of the Coke Oven Managers' Association, the Newcastle-upon-Tyne Branch of the Institute of British Foundrymen, and the North-East Coast Section of the Institute of Metals.

ferrous iron, but this is by no means definitely established. In selecting a firebrick for this and similar positions where lengthy exposure to CO (or certain hydrocarbons) is to be endured, a brick with a low iron content should be favoured.

Inherent Difficulties

The next great handicap to progress is that raw materials vary considerably. Clay can alter in composition within a few yards in a seam. Without a homogeneous raw material it is impossible to guarantee a homogeneous product, or to invent a simple method of manufacture which will give the best possible product from all the possible variations of the raw material. Not only clay, but other materials vary in the same way, *e.g.*, ganister, dolomite, chrome.

Another difficulty concerns testing, for testing of refractories is not so straightforward as with most other materials. A piece of steel tested in a recognised test-house almost anywhere in the world will give the same result for tensile strength, hardness, etc., but this is not found to be the case with refractory materials, which are usually tested under conditions which are very difficult to control accurately. In the refractoriness test itself, for example, the rate of heating of the test-piece, the atmosphere of the furnace, the size of the furnace, and the origin of the cones all have an influence on the result, and until testing furnaces and methods are standardised all over the world there will always be difficulties in correlating results.

Standardisation of Testing Methods Necessary

Temperatures are sometimes indicated by the behaviour of the cones, which are supposed to conform to a recognised standard. The problem of obtaining with certainty accurate cones is a very real and vital one. There is a need for standardising tests and testing methods, but as yet insufficient advance has been made to do this. It is extremely difficulty to say what tests are the most important, which are the tests which really give an indication of the suitability of a particular material for a certain job; for example, is a straight refractoriness test important, or should more reliance be placed on a test under load conditions? From what has been said about fireclay (and it applies in a degree to all other materials) it would appear that an underload test would give a better indication of actual behaviour; yet the most widely accepted specifications for refractories in this country—those of the Institution of Gas Engineers—do not mention an underload test.

In an underload test is one to use a constant load and increase the temperature to collapse as is done in this country, or is one to specify the temperature and load and hold these for a certain time as is practised in America? How far is the test to be carried out—to a certain degree of collapse or to complete failure? These and similar questions are yet to be decided, and until they are settled with some degree of unanimity by those best able to decide, it would be unwise for either user or maker to demand rigorous detailed specifications, except in cases where experience has shown what is really desirable.

Laboratory tests can be a guide, and help in selecting a brick for any purpose, but they must be correlated with actual furnace trials, and here again it is extremely difficult to obtain co-ordinated results. Even in one particular furnace conditions vary, if not from day to day, then from week to week, and it is difficult to obtain a co-ordinated series of trials in one works; where more are concerned it becomes almost impossible. How often has one heard of one manufacturer's bricks giving remarkable results in a works, while another user will not have them at any price?

From this it follows that refractories do not always receive the best treatment from the user. This is certainly the case, although users in general are becoming more "refractory-minded," and are beginning to discover that much can be done by a proper treatment of furnaces with a view to protecting refractories. One cannot stress too strongly, however, the importance of actual works trials, as far as possible under controlled conditions, for by this means the most valuable information can be gained, and, after all, the only way to convince a user that a brick is a good one is to let him see it do the job.

Overcoming Difficulties

In the first place, knowledge is increasing every year, not only of fundamentals, but also of the little "tricks of the trade" peculiar to any one works, or type of material. Knowledge of raw materials, their selection, blending and treatment, has definitely improved in the last ten years. Pretreatment of material before the actual brick-making operation, is becoming more general. This tends to even out irregularities in the raw material, and to stabilise many of the reactions which normally take place in the burning operation—usually associated with volume change. This stabilising robs the brick-making operation of some of its pitfalls, eliminates many causes of cracks, and makes possible better control of size. The use of grog and graded batches in the fireclay industry is a definite advance in technique. Grading is now considered important, whereas 15 years ago nothing was known of this subject. By suitable control of grading, the texture of a brick, its porosity, and permeability to gases can be controlled. Moisture content and factors affecting "plasticity" (although not much is known about that yet) are better understood. Drying and burning also are under better control, and kilns are no longer burned by the judgment of the burner's eye, or put off when a certain cone drops, but are controlled by pyrometer from start to finish, and definite firing schedules followed. All these refinements are essential if a uniform product of accurate size is to be obtained.

Operations are controlled, or at any rate "policed," by the laboratory. Most refractories works of any size now have a laboratory, carrying out the routine testing which is necessary for proper control of the process. Far from being a luxury as was once imagined, the laboratory has become a necessity. Metallurgists and others, who have relied on laboratory control for a generation or more, may express surprise that this should be mentioned, but only in quite recent years has laboratory control been applied to refractories.

Intricate Shapes

Much can be done, when designing intricate shapes, by a closer co-operation between the maker and the designer. Too often the designer of brickwork does not know enough about the properties of the different materials. He thinks in terms of the strength of his wall, tightness of his joints, bond of his brickwork, and the shape of his flues. Certain shapes which would appear to present no difficulties in manufacture, do present the utmost difficulty in practice, but by slightly modifying certain dimensions, this difficulty can in many cases be removed.

If a large proportion of a certain shape is cracked when drawn from the kiln, the stress causing the crack will be present in some degree in the remainder, and subsequently in service the same crack may develop in what are apparently sound shapes. It follows that a good principle to follow would be that if a shape tends to crack in manufacture, it will tend to crack later in use. Adherence to this principle would be profitable to both maker and user.

Multiplicity of Shapes

Scarcely two orders, whether for furnaces, retorts or ovens, are alike. Since the author's firm started making silica shapes 15 years ago, they have made over 60,000 different shapes; each of these needed a mould, and the majority needed special treatment in drying, burning, and other processes. Moulds used for one order are rarely needed again, and surplus material must be broken up and wasted. A typical modern coke oven has from 3 to 400 differently shaped bricks in its construction, and it very rarely happens that two batteries of ovens are built exactly alike—the next battery needs an entirely new set of moulds. In horizontal retort practice there is the same diversity of design. Horizontal retorts are built essentially in two sizes, 24 in. by 18 in. and 22 in. by 16 in. For these two sizes there are 45 different sets of moulds, varying only slightly as regards curvature, arrangement of joints, and design of corners, but by a little standardisation this could be reduced to four, and still retain all essentials.

All this variation causes increased costs, which are of necessity eventually borne by the user, although the maker's difficulties in handling such a variety of different shapes are considerable. Not only is co-ordination between user and maker needed to obtain simpler shapes, but also between users themselves to obtain some degree of standardisation.

The carbonising industries have benefited enormously by the introduction of the modern silica brick, which is strong at high temperatures, with no after-growth, and made to exact size and shape. There are still a few users in the gas industry who employ fireclay horizontal retorts—the quality and life of these (in common with most fireclay) is very much better than it was 15 years ago—but the very much greater life and superior thermal efficiency of silica, gain for it more and more users every year. In vertical retorts the use of silica for the combustion chamber zone is almost universal. Higher temperatures, quicker throughput, and increased fuel economy, are demonstrable advantages of silica in this industry.

Silica Bricks

The modern coke oven makes the use of silica essential, or rather it would be more correct to say that the use of silica makes the modern oven possible. With semi-silica, the height of the oven and the flue temperature were limited by the material which was weak at elevated temperatures and the lower courses of 7-ft. high oven walls regularly deformed or squatted. The use of SiO_2 made possible high ovens and high carbonising temperatures. Coke ovens are now being built with walls 44 ft. long and 15 ft. high, operating at flue temperatures of anything up to 1,420 deg. C., and carrying the load of heavy charging machinery. The material is strong under load at high temperatures, there is no after-expansion, and the thermal expansion need only be controlled during the heating up of a battery. The capacity of ovens has increased and the carbonising time decreased; thus while the throughput of coal per oven 20 years ago was about 7 tons per 24 hours, it can now be more than 20 tons. Not only are all new batteries built of silica, but old batteries can be rewalled with it; the only drawback in cases where this has been done appears to be that the increased yield of by-products causes embarrassment in the by-product plant! After the war, coke oven building slumped, and the industry has had a lot of lee-way to make up as a result, but this is now being done, and in the last three years, 24 batteries have been or are being constructed, absorbing 60,000 to 70,000 tons of silica.

In the iron and steel and non-ferrous industries, firebricks, silica and basic bricks are all used. Firebricks generally are a better shape, more even in size, and less likely to spall than they were a few years ago, but the most striking improvement is in the development of the high alumina brick, which has a high melting point and is less prone to slag attack than the brick of ordinary quality.

Firebrick Selection

The selection of a suitable firebrick for a particular job must be made with caution. In general, if the problem is one of temperature or resistance to slag, where ordinary firebricks

have failed, a high alumina brick might be better. The solution is not always one of refractoriness. In steel ladles, for example, a comparatively low refractory firebrick, properly burnt, of exact shape, and laid with dip joints, has been found to give better results than a brick normally classed as of better quality. These bricks rapidly develop a skin glaze, which renders them highly resistant to abrasion. In a melting shop where both acid and basic processes are used, this can be accelerated by using a ladle for acid casts when new, and after the glaze has developed, using it for basic casts.

Cupola Bricks

Cupola refractories must withstand a variety of conditions. Near the top, abrasion by the charge is considerable, and a hard wear-resisting brick should be used. Near the tuyeres level, very high temperatures are reached, and slag, high in iron oxide and frequently lime, is active. Ordinary firebricks give a very short life in this region. An improved life can be obtained by using well-made high alumina bricks which withstand the slag action at high temperature, and at the same time are mechanically strong. They should be well burnt to minimise after-contraction, which would open up joints and permit localised slag action.

The bricks should be specially shaped to fit the cylindrical form of the cupola, and of exact size to minimise joints. Joints may open and allow penetration of slag and exposure of five surfaces of the brick to slag attack. The jointing material should be chosen with care. A "straight" ground fireclay should not be used, as this will contract on heating up and open up the joint. A finely ground mixture of fireclay and crushed firebrick or grog is to be preferred. The grog lowers the shrinkage of the material and reduces the tendency for joints to open.

Spalling of Silica

Silica has also been improved for certain purposes, and by careful selection of raw material, properly graded and bonded, silica bricks are now produced having a resistance to slag and dust attack approximately twice that of a normal silica brick.

The spalling tendency of silica used to be the bugbear of the furnaceman, and by a proper understanding of the nature of spalling (it takes place at 150 to 400 deg. C. and not, as used to be thought, at high temperatures) this can be controlled. It is possible, however, to make a silica brick which is comparatively non-spalling by special selection and treatment of raw material, and proper control of the pore size and porosity of the finished brick. Such low spalling bricks are used successfully for hot patching work. The same type of brick has also been successfully applied to the rotary furnaces which are now being used in foundries, in which one of the most serious problems was the maintenance of the refractory lining. In this type of furnace the refractory lining is held tightly in a cylindrical steel shell, and the problems to be faced are those of expansion within this shell, of slag attack, abrasion during working, and the sudden rise in temperature each morning.

Basic Bricks

So far as basic bricks are concerned, the properties of magnesite have been improved as regards underload and strength. The underload strength, however, is still not high enough to enable furnace walls and roofs to be made entirely from this material. The spalling tendency of magnesite also is a serious handicap to its more general adoption, but a notable advance in basic bricks is the development of a composite magnesite-chrome brick, which, when properly composed and graded, has all the good points of a first-class magnesite brick, and in addition is entirely non-spalling.

Jointing Materials

No Paper on refractories is complete without a reference to jointing material, for a good brick could be ruined by an unsuitable cement, and the importance of proper selection of jointing cement cannot be stressed too much. In a ladle or cupola, joints should be as thin as possible, but in ordinary walling, especially where there is no slag attack and high temperatures are used, very thin joints should be avoided. In the past so many failures were due to joints that designers very naturally made these as thin as possible. The fault usually lay with the cement. Cements have been studied and improved to such an extent that it is possible to obtain cements of all qualities as resistant as the bricks themselves, and as joints do give a certain flexibility to a large structure, it is to be hoped that the very thin joint will soon become extinct. In this connection, however, it is important that bricks which tend to contract at high temperatures should be properly burnt (*e.g.*, firebricks). If they have not been so burnt, they may continue to contract in service and cause joints to open.

Another important development is the repairing of the walls of coke ovens and gas retorts by means of a fine spray of cement blown by air pressure on the defective parts. By this means, joints and cracks can be made gas tight and holes filled up, even in the most remote parts of the structure, without interrupting seriously the operation of the oven or retort—or indeed without cooling it unduly. This method of repair adopted as a regular maintenance job should have far-reaching effects in prolonging life and maintenance efficiency on all carbonising plants.

The author wishes to thank Mr. A. H. Middleton, of the Consett Iron Company, Limited, for permission to publish this Paper, and to acknowledge his indebtedness to those of his colleagues who have helped with suggestions and criticism in its preparation.

Notched Bar Bend Tests

Previous investigations on the effect of the dimensions of the specimen and of the notches on the alternate-bending strength have led to the view that these relationships cannot be reduced to any mathematical laws from which the alternate-bending strength could be derived for arbitrary sample dimensions from a test specimen of given dimensions. W. Kuntze and W. Lubimoff in Report No. 363 of the materials committee of the Verein deutscher Eisenhüttenleute, published in the "Archiv für das Eisenhüttenwesen," show that if the results of alternate-bending tests are arranged according to derived values for the depth of notch (ratio of notch depth to the diameter of the bar) and for the sharpness of the notch (sphericity of the notch base in proportion to the core diameter), some sort of law becomes apparent, which may be expressed as follows:—Series of bodies of different shapes which all have the same transverse strength, the material being the same, retain the same order of transverse values, although of different magnitudes, when they are enlarged in relative proportions. The authors suggest that on the basis of this empirical law it is possible, after making a series of tests with samples of uniform diameter and various forms of notches, to deduce the strength for a large structural element from a test on a small bar of the same material.

Particulars have been published of the Wombwell Foundry & Engineering Company, Limited. The authorised and issued capital is £65,000, divided into 650,000 shares of 2s. each. The business, which was formed thirty years ago, produces castings up to 30 tons, chilled rolls and screening plant. Permission has been granted to deal in the company's shares by the Manchester and Birmingham Stock Exchanges.

Desulphurisation in the Blast Furnace

A section in the U.S. Bureau of Mines Report of Investigation 3,331 is devoted to desulphurisation in the blast furnace, in which it is stated that desulphurisation is influenced by several factors, among which is slag composition. As this factor is readily controllable, it is desirable to know the relationship between the chemical composition of slags and their desulphurising power. A survey has been made and data in the form of charts and tables have been published showing the relative desulphurising power of slags within the following ranges of composition:—30 to 50 per cent. SiO_2, 5 to 25 per cent. Al_2O_3, 35 to 55 per cent. CaO, and 0 to 10 per cent. MgO. These data relate to tests made at one temperature, 1,500 deg. C. (2,732 deg. Fah.).

Similar data as to slags that contain up to 20 per cent. MgO have been obtained. In general, the results of the tests confirm the widely-accepted statement that an increase in basicity improves the desulphurising character of a slag. However, no simple relation was found between desulphurising power and basicity, according to any of the commonly-used definitions of the latter.

In the past there has been much speculation as to the effect of viscosity change on desulphurisation, and much work has been done on the determination of the viscosity of slags of widely varying composition. Viscosity may be controlled partly by controlling the chemical composition of the slag, but any change in composition is accompanied by a change in the slag's chemical activity. A comparison of the desulphurisation data with McCaffery's viscosity data reveals that in many cases a decrease in viscosity is accompanied by an improvement in desulphurisation, but in others the relationship is opposite. It is evident that a slag may be too viscous to permit ready mixing of the products of the desulphurisation reaction or to permit movement of metal drops and gas bubbles through it. Thus, while increasing basicity up to a limit improves desulphurisation, further increase in the basicity results in a rapid decline in desulphurisation as a result of a thickening of the slag. Any treatment that would thin such a slag without decreasing its basicity might be expected to be beneficial from the standpoint of desulphurisation. This was found to be true. When the temperature is increased, the slag becomes thinner, and better desulphurisation occurs. Also, when MgO is substituted for part of the CaO in a highly basic slag, a thinning effect is obtained and desulphurisation is improved. This improvement occurs in very basic slags, although in general MgO seems to be a less effective desulphurising agent than CaO.

Tests have been made on numerous slags at temperatures other than 1,500 deg. C. In some ranges of composition temperatures of 1,475, 1,525 and 1,550 deg. C. have been used. So far as these tests have gone, the effect of composition is similar at all probable blast-furnace temperatures. Desulphurisation with any slag is improved by raising the temperature, but particularly is this true of the highly basic slags, as noted above.

The accepted desulphurisation reaction is this:

$$FeS + CaO \rightleftharpoons CaS + FeO.$$

In practice, another reaction plays a significant part:—

$$FeO + C \rightleftharpoons CO + Fe.$$

If this action were to proceed indefinitely, the FeO would approach zero and, in turn, the metal would become completely desulphurised. Such a condition never obtains in the blast furnace, because FeO is being replaced continuously in the form of incompletely reduced ore, and as a result of oxidation in the combustion zone.

Quantity Production of Railway Steel Castings in Canada

By E. G. FIEGEHEN, M.I.Mech.E.

(*Concluded from page 176.*)

One feature of the lay-out of the moulding unit which provoked some criticism when it was proposed was the unusually great distance (130 ft.) that separates the drag and cope machines. The decision to adopt this distance was based upon the fact that about thirteen separate cores have to be placed in a side-frame drag-mould after it leaves the moulding machine. To keep pace with the rapid production of moulds (seven minutes per mould) a sufficient number of core-setters had to be employed, and their work requires care.

The necessary baked cores are received upon lifting racks from the core department in the adjacent aisle, and are stacked behind the boarded platform (alongside and to the east of the conveyor) in orderly sequence. The core-setters work on the platform with the cores that they require within easy reach behind them and as soon as they have set the core for which they are responsible, they push the box to the man next in the line who adds another core, and so on. The journal-box cores are made in green sand and a sand bin, bench, metal moulding boxes and pneumatic sand rammers are located for their production in the proper place so that they may be handed to the core-setter in the proper sequence.

The drag moulds, moving northwards, thus progress until they arrive, completed, at a point where they meet cope moulds travelling southwards. The cope moulds contain no cores but have holes for the pouring head and riser. Moulded runner basins are stacked ready at the meeting point.

The 3-ton overhead electric crane is mounted upon a short gantry at this point and the bottom box is lifted by lifting beam with suspension links terminating in ball-bearing eyes which engage the box trunnions. The bottom box is now deposited upon the roller-conveyor pouring line which slopes southward, there it is dusted with the air hose, inspected and gauged. The crane next lifts the nearest top box which is turned over, inspected and dusted, and is then lowered on to the bottom box, being aligned by pins, to which it is then clamped.

Pouring and Knocking-Out

The pouring and riser heads are then fitted in place and covered by sheet metal discs to exclude dirt. The closed mould is then pushed southwards down the pouring line. When sufficient moulds are ready to pour, a bottom-pouring ladle is transferred from the open-hearth department by the transfer car. It is then lifted by one of the heavy cranes and travelled along the line of moulds—filling them in succession.

By the time all are poured a gang can start at the north end and knock off the runner basins and box clamps, returning the latter to the closing point for re-use. The cranes now remove the top boxes, shake them out over the grating and return them in piles of five to the sides of the cope machine. The bottom boxes are similarly shaken out to remove the castings and sand and the empty boxes are returned to the drag moulding machine.

Some moulds shake out easily with the assistance of crow-bars, but others may require the application of a pneumatic rapper which hooks over the end of the box and imparts heavy vibration. The hot castings which have been discharged upon the floor are then collected by the crane and placed upon skids to cool; surplus sand is shovelled to the grating. When the castings are sufficiently cool, they pass to the fettling floor, which is served by a 3-ton overhead electric crane upon a short gantry, where labourers knock off the heads and risers, and they receive a preliminary superficial examination for defects.

Annealing

The castings have next to be annealed to relieve casting strains and to improve the grain size of the metal. The two annealing furnaces are located alongside the fettling floor, and as soon as a furnace bogie is available, the castings are stacked upon it on rail skids; about thirteen side-frames or twenty bolsters form a load. Stacking has to be done carefully to ensure that each casting shall receive its share of radiant heat, and is so supported that it will not distort when red-hot.

The annealing furnaces are of the bogie-bottom type, 21 ft. long by 9 ft. 4 in. on the hearth and 5 ft. 2 in. high to the arch. They are oil-fired and fitted with six-point recording pyrometers. The temperature chart of each heat goes to the works laboratory for record. As soon as one batch of castings has been annealed the doors of the furnace are opened and the heated bogie run out, whilst a second car with cold castings enters at the other end for treatment.

The doors are closed and the castings remain in the furnace 1¾ hours at a temperature of 895 deg. C. About half of this period is occupied in bringing the castings up to heat, and for the remainder of the time they "soak" at that temperature. On completion of the heat, the castings are run out and left on the bogie to cool in the air; when they have cooled sufficiently to enable them to be slung, the bogie is unloaded to free it for another batch.

Cleaning

The next operation is that of cleaning all accessible surfaces of the castings by the sand blast and for this purpose they are placed upon special feeding-rails and pass into sand blast rooms, which are specially ventilated with an exhaust system. The operator wears a special dust-excluding helmet and cleans the castings by means of the sand jet, the sand falling through a grating in the floor to a screw conveyor for disposal, whilst the dust from the rooms is collected by a dust collector operated by a fan.

After leaving the sand blast the castings are inspected and any that may be found distorted by comparison with testing gauges are taken to a 400-ton press to be straightened. The castings are next laid upon special rail benches and all fins and roughness are removed by chipping with pneumatic chisels and by grinding with portable electric grinders. When this has been done satisfactorily, fitters face up the journal-box lid openings and clean up the pin-holes so that a dummy journal-box cover will fit correctly, they also dress up the lugs for brake hangers, etc.

Inspection

The castings are now ready for the foundry company's inspectors whose work is facilitated by many special gauges. If they discover blow-holes or slight defects these are marked and the castings are ready for the railway company's inspector whose permission will be sought for the correction of slight defects by electric-arc welding. For this work adequate equipment is provided and a very satisfactory job can be made under the control of experts. Any castings found to be defective are sent at once to the scrap pile, and each casting that has been finally approved is weighed in the presence of the railway company's inspector who will reject any the weight of which does not conform to the tolerance allowed.

As an example of weight control a certain side-frame casting may be cited. The standard weight upon which the contract price is paid is 540 lbs. and castings must weigh between 524 lbs. and 545 lbs. to be accepted. Similarly, a typical bolster casting has a standard weight of 786 lbs. and an allowance of from 762 lbs. to 794 lbs. It will be seen that the above examples indicate, roughly, one per cent. tolerance above normal weight and three and a-half to four per cent. below. These are fairly rigid restrictions when the thinness of the metal is taken into account. One of the satisfactory features of the new moulding equipment has been the very close weight control secured.

Coupler Moulding Department

In the coupler moulding department (Fig. 4), at the north of the aisle, it will be seen that there is a group of six machines, arranged in a row on the west side of the aisle. These are arranged for operation in three pairs, each pair consisting of a cope machine and a drag machine, and one pair is devoted exclusively to the production of one coupler component.

At the north end of the row are two 27-in. by 30-in. jolt-stripper machines making "lock" castings. In the middle is a pair of 40-in. by 60-in. machines of the same type making coupler bodies, and, finally, another pair of 40-in. by 60-in. machines making knuckles. Each pair of machines is served by three swing jib cranes fitted with air-hoists. A sand bin is located behind each machine which is filled by a drop bottom sand box handled by the overhead cranes. Each moulding machine is housed in a reinforced concrete pit and the tables stand a few inches above the floor line. Empty boxes are piled at the sides of each machine.

A good supply of lifting skids is provided; each holds five 2-part boxes and as the bottom boxes are rammed they are lifted from the machine by the jib crane and deposited upon the skid. The top boxes are then laid upon the bottom boxes and the moulds are clamped and pouring cups put in place. The loaded skid is then lifted by the overhead crane and placed upon the pouring conveyor ready to receive the metal which is transferred from the open-hearth department.

The latest coupler to be produced is a complicated casting and requires several cores. Metal patterns are used and these include some loose parts. The knuckle and lock castings are simpler, and more than one can be made in a box.

Immediately to the south of this group of coupler moulding machines is another moulding unit to handle draft-gear and miscellaneous castings. This consists of a 28-in. by 36-in. "Davenport" roll-over moulding machine making drag moulds, and a 30-in. by 42-in. plain jolt machine making cope moulds. These are served by a sand bin placed between them and there are a transfer track and jib cranes at the back. The drag moulds when complete are placed upon the transfer truck and pushed in line with the cope machine. Here the copes are placed upon the bottom boxes and the moulds are closed, lifted on to the roller conveyor and moved eastwards ready for pouring.

After the risers and gates have been knocked off the castings in this department they are loaded by the overhead cranes on to railway wagons and shunted to the coupler cleaning department where they are annealed, sand-blasted, trimmed, fitted, inspected, load-tested and despatched.

Core Making

To cope with the greatly increased demand for cores many additions and improvements had to be made to the existing core department. An additional overhead crane was installed and sand mills were re-arranged for more efficient service. A group of three "Simpson" 6-ft. mills were erected upon foundations at the south end of the new-sand storage bins and were sufficiently elevated to discharge direct into sand boxes upon the floor.

Sand was supplied to the mills by an overhead crane and grab. Several new oil-fired core-baking ovens of the bogie type were installed and old ovens were brought up to date by the provision of air-circulating systems. Light welded ribbed core plates replaced the heavy cast plates formerly in use, several new moulding machines were installed and roller-conveyor lines were provided to expedite the work. The core-benches were re-arranged and sand bins were located above them. For hand-made cores the number of metal core-boxes was materially increased.

Summary

Experience with the new equipment has been very satisfactory. A production of one hundred and fifty side-frame castings is secured during a 10-hr. shift; this is equal to one casting every 4 min. In comparison, the old machines took 14 min. to produce a mould. Couplers complete with all parts are produced at the rate of one hundred per 10-hr. shift, which is equivalent to one every 6 min.

The conditioned sand supplied to the moulding machines is now of high permeability, and the ramming produces an even density, with the result that the castings have a fine surface and require the minimum amount of dressing in the cleaning department.

Wherever possible, metal patterns and core-boxes are used to ensure a mechanical accuracy rarely associated in the past with steel foundry work, and resulting in this case in close weight control. The percentage of defective castings has been remarkably low.

The amount of additional new sand required fell from the start and has reached a steady low percentage that compares favourably with former experience. The permeability, moisture content, bond and green strength of the sand supplied are subject to a continuous check by the sand-testing office, and as the result of this a small number of standard sand mixtures has replaced a much larger number formerly deemed essential.

The prompt disposal of the shake-out sand enables the foundry floor to be kept clean, and the high output and ordered sequence of operations ensure that the stock of boxes is kept in constant circulation, thus justifying the initial outlay upon them.

It has been observed that the "Osborn" machines can fairly easily keep ahead of the core-setters at the present rate of production, and it is quite possible that this could be increased somewhat if required.

The conditions under which sand-handling machinery has to work subject it to great wear, and one advantage presented by individual electric driving of units is the facility with which the power supplied by any motor can be measured, for an abnormally high or fluctuating reading directs attention to the mechanical condition of the unit before failure actually occurs.

A good supply of spare parts is kept in stock, and replacement is, in general, very easily effected. For example, chain sprockets have renewable bolted pins, and journal boxes are split and are of a design which includes few details that are difficult of access.

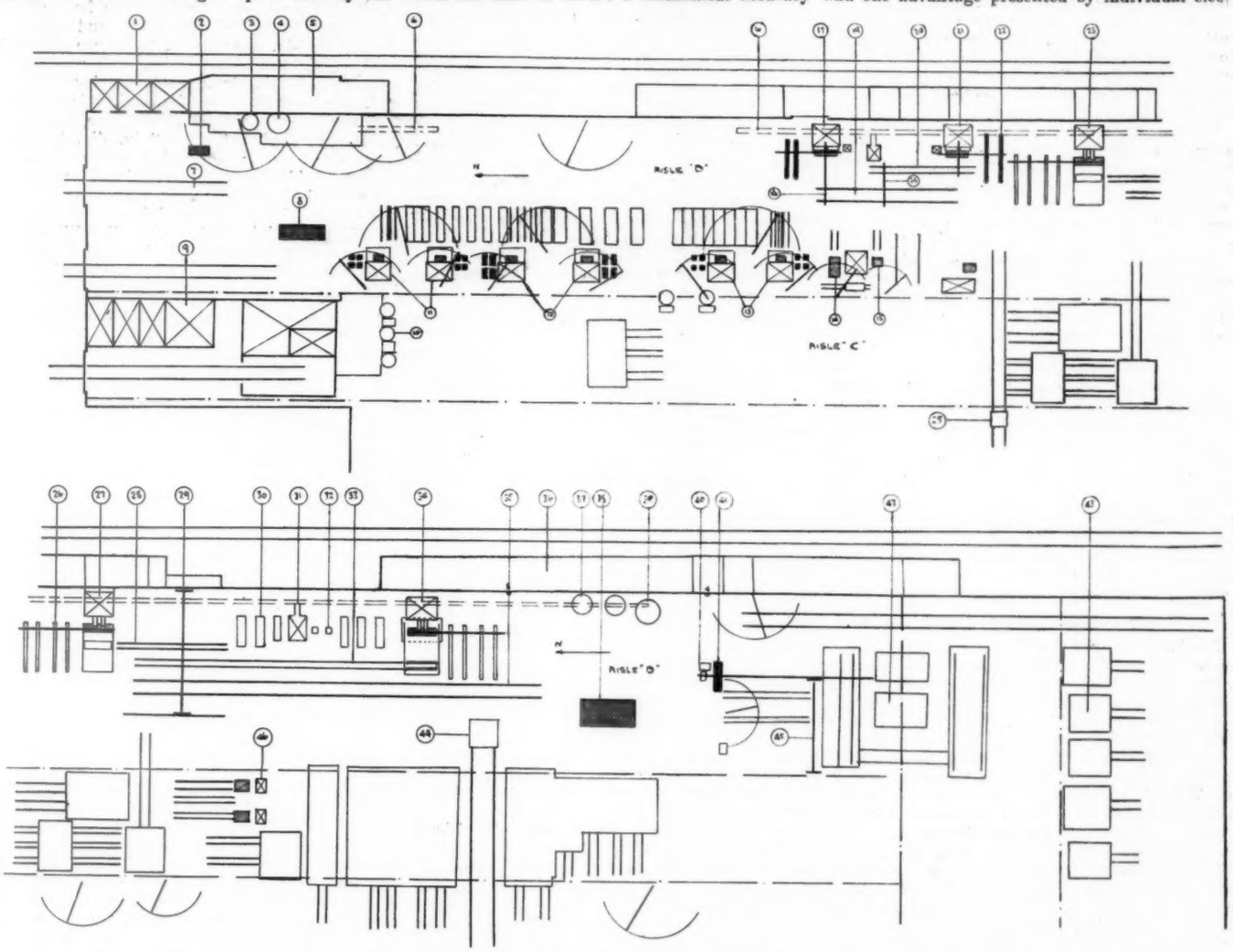


FIG. 4.—GENERAL LAY-OUT OF FOUNDRY.

1. Three sand bins. 2. Knock-out grating. 3. Facing-sand mill. 4. Floor-sand mill. 5. North-end sand system—Coupler Department. 6. Distributing belt for conditioned sands. 7. Railway track to coupler cleaning department. 8. Shake-out grating. 9. Group of sand bins. 10. Group of 3 Simpson mills in the core department. 11. Moulding machines producing lock moulds. 12. Moulding machines producing coupler moulds. 13. Moulding machines producing knuckle moulds. 14. Davenport B.O. moulding machine. 15. Jolt moulding maching. 16. Distributing belt for conditioned sand. 17. "Welland" cope moulding machine. 18. Runway and electric block for copes. 19. Pouring line roller conveyor. 20. Drag mould conveyor. 21. "Welland" drag moulding machine. 22. Conveyor for empty boxes. 23. "Osborn" moulding machine for copes. 24. Runway and electric block for closing moulds. 25. Ladle transfer car for coupler department. 26. Conveyors for empty cope boxes. 27. "Osborn" moulding machine for cope moulds. 28. Conveyor for cope moulds. 29. 3-ton overhead electric crane for closing moulds. 30. Core racks. 31. Sand bin for journal box moulds. 32. Journal box moulds. 33. Roller conveyor for drag boxes. 34. "Osborn" moulding machine for drag moulds. 35. Pouring conveyor for moulds. 36. South end sand system. 37. "Simpson" floor sand mills. 38. Shake-out grating. 39. Facing-sand mill. 40. Knock-out rapper. 41. Knock-out grating. 42. Two annealing furnaces. 43. Five sand blast rooms. 44. Ladle transfer car-side-frame and bolster department. 45. 3-ton electric overhead crane for fettling floor. 46. Davenport roll over moulding machine for cores.

Further Developments with Coal-Dust in Moulding Sands*

By BEN HIRD

Introduction

Since the first investigations into the action of coal-dust in mouldings sands, eight years ago, the author has from time to time made further experiments and practical tests with this material. Other investigators, notably Hudson and Winterton, have also made valuable contributions to the subject. The full value of coal-dust additions to moulding sand has not yet been thoroughly realised, and there is scope for further investigation and practical application of this material in the foundry.

The first Paper† by the author dealt with the action of coal-dust on the skin of grey iron castings, and gave a few tentative remarks on the appearance of the sand after the casting was removed from the mould. The further developments to be outlined deal mainly with its effect on the properties of the moulding sand.

Dealing first with the action of coal-dust in preventing the formation of scabs on the face of castings the three most common are the "solid scab," the "blind" or "sand buckle scab," and the "scour or runner scab."

The Solid Scab

The solid scab is formed when a portion of the sand from the mould face lifts, or buckles, either as soon as the molten metal covers it, or immediately before the metal reaches it, due to the radiation of heat from the metal. In this case the sand floats on the rising metal, and is deposited on the sides or top of the mould and forms shallow holes in the casting. The cause may be one of many: a patch of weak sand; a wet spot; a hard spot; ramming too near the pattern; faulty patching; neglected or poor venting or badly mixed or unsuitable sand.

Blind or Sand Buckle Scab

The blind or sand buckle scab is very closely related to the solid scab, but occurs at a slightly later period, during the filling of the mould, instead of being washed away by the flow of the metal, it is now held in its place. Imagine the temperature of the sand forming the face of the mould suddenly raised to a temperature of 800 or 900 deg. C. for a depth of about $\frac{1}{32}$ of an in. This high temperature causes the grains of sand to expand, and when certain conditions prevail, patches of sand buckle up into the molten metal. A very thin skin, which will then have formed on the metal, prevents this sand from floating away, but is not strong enough to resist the force of the pressure, causing the buckle, which presses inwards in the form of an angle, the apex of which cracks, and allows metal to bleed into the cavity formed through the crack as shown diagrammatically in Fig. 1.

Scour or Runner Scab

Scour or runner scabs usually form at or near the place where the metal from the runner, entering the mould, strikes the mould face, or core. It is of the solid type and is due to the breaking down of the bond of the sand grains, by the cutting action of the falling metal. Once the surface grains give way they crumble rapidly until sufficient depth of metal has formed to protect them.

For many years foundrymen have known that the addition of coal-dust to facing sand helps to prevent the formation of these scabs, but the reason is not well known. Investigations have led to the following conclusions:—The intense heat from the molten metal as it fills the mould first gasifies the particles of coal that are mixed in the sand forming the mould face, but the coal-dust immediately behind the mould face, being out of direct contact with the molten metal, partially metamorphoses into a tar containing gases. As these gases escape, due to rapidly increasing heat, they swell the small particles of tar, and push them into the pore spaces, and around the sand grains. This bonds the grains together much in the same way that flints covered with tar bond together in asphalt or tarmac roads. This action forms what is best termed a "hot bond" for the grains of sand, effectively preventing them from slipping or buckling. As the temperature increases, this tar cokes, and the sand grains are now held with a very strong bond.

Improved Green Bond Strength

The author has made a considerable number of experiments definitely proving that coal-dust additions to moulding sand creates green bond strength, and a practical application over a long period has confirmed the experiments. These latter were carried out on two continuous casting tracks, making railway chairs. Incorporated in the tracks was a continuous sand mixing plant which operated as follows:—After the castings were removed from the moulding boxes the hot sand was knocked out over a grating, and fell on to a belt conveyor. It was then elevated into a "Ketting" mill. While the sand was in the outer mixing ring 2½ per cent. of fine coal-dust was added, and 6 per cent. of water, and when mixed it was passed into the centre, and milled for three minutes. From the mill it passed through a disintegrator and was then conveyed by overhead belts to the moulding machines. For over two years no new sand was added, only the 2½ per cent. of coal-dust. Periodically, when the sand got too strong, burnt old sand was added to bring down the strength to the standard which was kept at 14 to 16 lbs. total load on a 2-in. by 2-in. A.F.A. sample, or 4½ to 5 lbs. per sq. in.

Summary of Some Coal-Dust Bond Experiments

For the purpose of these experiments, moulds were made from a rectangular block, 12 in. by 8 in. by 2½ in. thick. Enough sand was mixed to make one mould, with sufficient over to allow for loss during subsequent re-mixings. After each cast, the mould was allowed to cool down to room temperature, before the casting was removed. Tests with both "hand mixed" and "milled" sands were made. The hand mixed sands were turned with a shovel, and then put through a ¼-in. sieve twice, to ensure thorough mixing. In the milled series, each re-mix was milled for 3 min. in a small double-roller pan mill. To concentrate on the bond, only strength test results are given. These were taken on A.F.A. standard test piece 2 in. dia. by 2 in. long, tested on a spring-balance compression testing machine, and the total breaking load is given in all tests.

The analysis of the coal-dust used was:—Volatile, 30.6; ash, 10.4; carbon (by difference), 59 per cent.; fineness, all through a 90-mesh sieve. The moisture of all mixtures was between 4 and 6 per cent.

Experiment No. 1.—Stourbridge Red Sand.—Ten per cent. of coal-dust was added, but no further additions were made.

Hand Mixed

Original mix before making first casting. Breaking strength 13 lbs.	Condition of castings.
Re-mixed after first casting 8 lbs.	Good blue skin.
,, ,, second ,, 8 ,, ...	,, ,, ,,
,, ,, third ,, 7¾ ,, ...	Good. Rather grey skin.
,, ,, fourth ,, 7½ ,, ...	,, Rough grey skin.
,, ,, fifth ,, 6 ,, ...	,, ,, ,, ,,
,, ,, sixth ,, 5 ,, ...	Poor. Top face drawn down slightly. Very rough grey skin.

Experiment No. 2.—Stourbridge Red Sand.—Ten per cent. of coal-dust was added, but no further additions were made.

Milled

Original mix milled before making first casting. Breaking strength 23 lbs.	Condition of castings.
Re-milled after first casting 20 lbs.	Good blue skin.
,, ,, second ,, 20 ,, ...	Dull ,, ,,
,, ,, third ,, 21 ,, ...	Grey ,, ,,
,, ,, fourth ,, 21½ ,, ...	,, ,, ,,
,, ,, fifth ,, 23 ,, ...	,, ,, ,,
,, ,, sixth ,, 22½ ,, ...	,, ,, ,,

The results of Experiment 1 are normal, for the strength of the sand decreases after each cast. In striking contrast, the milled series No. 2 show an increase of strength after the first two castings. Obviously, the sand is gaining bond from some source other than the clay bond or alumina in the red sand grains. Microscopic examination of the sand after the fourth cast showed all the grains were covered with a black carbon deposit, which must obviously destroy the clay bond. This suggested a bond created by coal-dust, so further experiments on the same lines were made with sharp sand to prove this.

Experiment No. 3.—Sharp Sand (Briton Ferry) Dune Sand.—Ten per cent. of coal-dust added to original mix. and 2½ per cent. added after each cast.

Milled

Original mix before making first casting. Breaking strength 2½ lbs.	Condition of castings.
Re-milled after first casting 6 lbs.	Rough grey skin. Top pulled down.
,, ,, second ,, 8½ ,, ...	Better. Grey-blue skin.
,, ,, third ,, 10½ ,, ...	Good. Better blue skin.
,, ,, fourth ,, 13½ ,, ...	,, ,, ,, ,,
,, ,, fifth ,, 15 ,, ...	,, ,, ,, ,,
,, ,, sixth ,, 16½ ,, ...	,, ,, ,, ,,

The result of this experiment proved beyond doubt that the tar from the coal-dust liberated by the heat of the metal when the mould was poured was creating an excellent bond, espe-

* A Paper read before the Newcastle Branch of the Institute of British Foundrymen, Mr. Smith presiding.

† Foundry Trade Journal, June 27, 1929, p. 493.

cially after milling. Another experiment with sharp sand plus coal-dust, but this time hand mixed, proved that milling increases the bond.

Experiment No. 4.—Sharp Sand (Briton Ferry).—Fifteen per cent. of coal-dust added, then decreasing amounts of 5, 4, 3, 2, and 1 per cent. added after each cast.

HAND MIXED

Original mix before making first casting. Breaking strength 3½ lbs.		Condition of casting.
Re-mixed after first casting	6½ lbs.	Rough casting. Fair blue skin. Top pulled down.
,, ,, second ,,	6½ ,,	,, ,, ,, ,, ,,
,, ,, third ,,	7½ ,,	,, ,, ,, ,, ,,
,, ,, fourth ,,	5½ ,,	Better casting. Rough grey skin.
,, ,, fifth ,,	6½ ,,	,, ,, ,, ,, ,,
,, ,, sixth ,,	5½ ,,	,, ,, ,, ,,

Although the condition of the sand was better than the test results show, this experiment definitely proved the benefit of milling, to produce this bond from the coal-dust.

Experiment No. 5.—King's Lynn Sharp Sand.—Ten per cent. of coal-dust was added to the first mix, and 3 per cent. after each cast.

Cast.	Coal-dust. Per cent.	Strength. Lbs.	Perm.	Moisture. Per cent.
Milled—				
First mix ..	10	3½	134	4½
After 1st cast	3	5¾	93	5
,, 2nd ,,	3	8¾	70	5
,, 3rd ,,	3	12½	52	5
,, 4th ,,	3	17	40	6
,, 5th ,,	3	18¾	32	6
,, 6th ,,	Nil	19½	30	6½

Experiment 5 was made this year with King's Lynn sharp sand, and a fine coal-dust made by a well-known firm of suppliers.

Castings made with this sand were good, even the first one cast in sharp sand and raw coal-dust was free from cuts, scabs and pulling down of the top. This was unusual, for previously castings in sharp sand had shown some, or all, of these defects. After leaving coal-dust bond sand for a considerable time, and air drying it to powder, its original bond strength may be obtained without remilling by remixing with 5 to 6 per cent. of moisture.

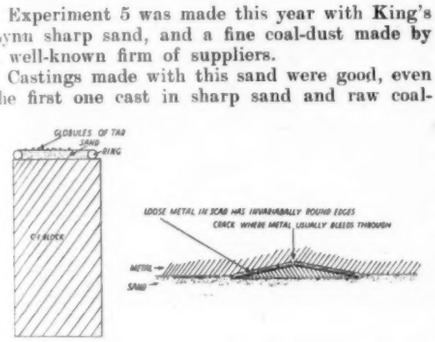


FIG. 1 (RIGHT).—SECTION OF BLIND SCAB SHOWING ANGLE WHICH PROVES EXPANSION OF SAND, AND FIG. 2 (LEFT), SECTION OF CAST-IRON BLOCK AND RING CONTAINING SAND.

Conclusions

It should be clearly understood that raw coal-dust does not create this bond. It is the deposits from the coal when they are transformed by the heat from the metal as it penetrates into the sand of the mould during and after pouring. These deposits coat some of the sand grains with a black sooty carbon and a certain amount of tar, and it is this last product which creates the bond which is partly frictional, *i.e.*, gripping the rough carbon surfaces, and partly glutinous, *i.e.*, tarry residue.

Microscopic examination of the coated grains and a simple experiment confirm this theory. For the experiment a small ring about 2 in. dia. is made with a piece of $\frac{3}{16}$-in. or ¼-in. wire. The centre of the ring is firmly filled with a mixture of sharp sand plus 10 per cent. of coal-dust, plus 4 per cent. of moisture. A small block 2 in. sq. by 4 in. long is then cast, and as soon as the casting sets it is removed from the mould and the ring filled with sand is placed on the 2 in. sq. end. With careful observation small globules of tar will be seen pushing up between the grains of sand (Fig. 2). Other interesting points also confirming the presence of "hot-bond" will be observed.

A study of the heat penetration diagram, Fig. 3, built up from results taken by F. Mask and E. Piwowarsky, and applied approximately to the test block, 12 in. by 8 in. by 2½ in. will be found interesting. Assuming the mould is made of well mixed sand plus fine coal-dust, one can follow in imagination the changes that take place in the sand from the time the metal enters the mould until the casting is cold.

As soon as the metal enters the mould the particles of coal on the bottom face give off their volatiles in the form of smoke immediately in front of the flowing metal, this smoke is trapped between the flowing metal and the mould face, the action takes place very rapidly on the bottom face, and then on the sides as the metal rises. The coal-dust on the top face gets the full effect of the radiated heat from the rising metal and the particles of coal on this face have already liquefied to tar before the metal reaches them, and created a very effective hot bond which prevents the sand from drawing down. The mould is filled in a few seconds, and the heat from the metal has started to penetrate the sand; this takes place slowly as shown by Fig. 3. At the mould face the temperature is approximately 900 deg. C.; as soon as the metal covers the face there is practically no air present to burn the coal-dust, so it melts into the form of a tar, at the same time gases form in the tar and exert a pressure trying to escape, this pressure forces the tar into every available space between the sand grains, and the liberated gases are forced back through the still unaffected and cool parts of the mould, where any tars they contain are condensed on to the grains of sand. This evolution of tar and gas continues into the mould as far as the heat required to cause it penetrates.

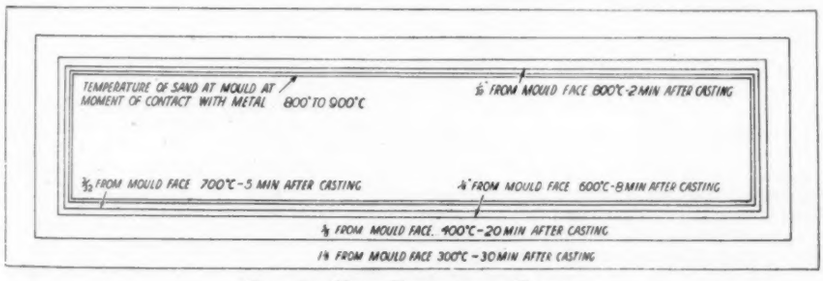

TEMPERATURE OF SAND AT MOULD AT MOMENT OF CONTACT WITH METAL 800°TO 900°C
½" FROM MOULD FACE 800°C-2 MIN AFTER CASTING
½" FROM MOULD FACE 700°C-5 MIN AFTER CASTING
¼" FROM MOULD FACE 600°C-8 MIN AFTER CASTING
¼ FROM MOULD FACE. 400°C-20 MIN AFTER CASTING
1" FROM MOULD FACE 300°C-30 MIN AFTER CASTING

FIG. 3.—HEAT PENETRATION CHART.

Behaviour of Steel at High Temperatures

M. HEMPEL and H.-E. TILLMANNS, in Report No. 308 of the Mitteilungen aus dern Kaiser-Wilhelm-Institut für Eisenforschung zu Düsseldorf, entitled "The Behaviour of Steel at High Temperatures under Variable Tensile Loads," point out that a critical survey of the literature dealing with the fatigue strength of steels at high temperatures indicates that the published values for temperatures from 300 deg. onward are on the whole spread over a wide range above the 0.2 limit or the fatigue limit. It appears that no investigator has given proper consideration to the creep or flow phenomena which may be expected to occur in these temperature ranges when the material is placed under an alternating load, but that the Wöhler method applicable at ordinary temperatures has been applied without modification.

The authors' own investigations, which were carried out on a comprehensive scale, were preceded by a series of preliminary researches into experimental procedure, such as the regulation and uniformity of temperature levels, the optimum shape of test-bar and method of attachment. A pulsator machine was employed for applying an alternating tensile load and the test-bars heated in a liquid bath. For a carbon steel, a molybdenum steel and a Cr-Ni-W steel, the following values were first determined. The 0.02 and 0.2 limits by statical short-time and long-period tests, the endurance and tensile limits, also elongation and reduction of area at temperatures up to 500 and 600 deg. Using the Wöhler method with an alternation frequency of 2 million for the limiting load, the elongating load was determined for the same three materials at different temperatures, the elongation being observed under a gradually-increasing load. The maximum elongation observed was 13 per cent. and the rate of elongation found to be 200 to 400 10^{-4} per cent. per hr. at a load-alternation frequency of 1.8 to 2.2 million, such values being too small to be of practical significance.

A mechanical-optical recorder is also described for registering the creep under repetitive loads, and which enabled the rate of elongation to be measured very accurately. At elevated temperatures comparative tests were made with a static load and with a repetitive increasing load at two frequencies (50 and 500 alternations per min.). The elongation curves obtained in the two cases were approximately the same, provided the upper load limit was the same in both. The conclusion is drawn from the experiments made that the elongation with an expanding load is determined by the upper limiting load and that for the ranges and materials investigated there is no relationship between the frequency of repetitive loading and elongation.

American Foundrymen's Association

The Nominating Committee of the American Foundrymen's Association met recently to prepare and present a panel of officers and directors subject to election at the Convention and Exhibition to be held in Milwaukee from May 3 to 7. The following were nominated for officers and directors:—For President: Mr. Hyman Bornstein, chief chemist and metallurgist, Deere & Company, Moline, Ill.; for Vice-President: Mr. Marshall Post, Vice-President and works manager, Birdsboro Foundry & Machine Company, Birdsboro, Pa.; for directors to serve three terms each: Mr. Duncan P. Forbes, President, Gunite Foundries Corporation, Rockford, Ill.; Mr. H. B. Hanley, foundry superintendent, American Laundry Machinery Company, Rochester, N.Y.; Mr. C. J. P. Hoehn, President, Enterprise Foundry Company, San Francisco, Calif.; Mr. Thomas Kaveny, President, Herman Pneumatic Machine Company, Pittsburgh, Pa.; Mr. C. E. Sims, supervising metallurgist, Battelle Memorial Institute, Columbus, Ohio; and Mr. James L. Wick, Jr., President, Falcon Bronze Company, Youngstown, Ohio.

D

Crofts (Engineers), Limited

JUBILEE CELEBRATION

Fifty years ago specialisation in any branch of engineering was the exception rather than the rule. Power transmission if not actually crude was, at any rate, not regarded as a serious scientific proposition and therefore there was, in the abstract, very little to encourage the engineer to commit himself to the specialisation of power-transmission machinery and appliances. The present is the age of the specialist, and, indeed, it is only by specialisation that we can hope to effect radical improvement in plant or process.

Fifty years ago the late Mr. F. L. Croft visualised the future possibilities of power-transmission machinery, and from the very outset he realised that only by specialisation could those possibilities be realised, and to that end he devoted the whole of his business life. It is, however, more than doubtful if even he anticipated when he established himself as the Patent Pulley Company at a small workshop in Monk Street, Bradford, that he was laying the foundation of what has since become the largest works in the Kingdom devoted solely to the wide range of products included in the term power-transmission machinery, *i.e.*, belt, rope, chain and gear drives, geared motors, etc. In that small workshop Mr. Croft employed about seven hands for the manufacture of his patent wrought-iron pulley, at the time a revolutionary departure, in which the use of a specially-rolled rim gave the advantage of light weight, exceptional strength and secure rivet hold for the pulley arms. A few years after its establishment in 1887 the firm became Croft & Perkins, and at once took up the manufacture of general mill-gearing products in addition to the pulleys, and the firm moved into larger works in Lower Essex Street, Bradford, in 1891.

As specialists, the firm speedily built up a high reputation and their products were in demand in workshops, mills, collieries, etc., in all parts of the country. A considerable export trade had also been developed and extensions were required to cope with the ever-increasing demand.

The Lower Ernest Street Works were in a congested area, and as it was not only immediate requirements but future possibilities which had to be considered, a site was acquired at Thornbury in 1898, and on this site the present works cover some 14 acres and find employment for 1,200 workpeople. Up to that time the necessary iron castings were made in a small foundry which the company had acquired in the Leeds Road district of Bradford, the output of which was quite unequal to the demand.

In 1902 the north-west corner of the Thornbury site was laid out for a pattern shop and stores, and at the same time the erection and equipment of the iron and non-ferrous foundries was proceeding, the first melt being poured in 1904. During the succeeding several years the erection of new shopping was continually in progress. It was during this period that Mr. T. A. Perkins retired from the business, and subsequently the firm was reconstructed under its present style of Crofts (Engineers), Limited. By this time office accommodation had to be provided for a substantial increase in staff, to meet which demand the company built the imposing suite of offices which front the western side of the works and in which are also housed extensive drawing offices; at the same time on a site opposite the office block they built a canteen with seating capacity for 800 to 1,000 employees.

After the war the general tendency towards electrical driving changed entirely the nature of power-transmission products required. Individual and group driving is now, of course, very generally employed, and with the high-speed prime movers came also the general introduction of reduction gears, geared motors, short-centre drives by vee ropes, chains, gearing, etc.

Pioneers in the development of power-transmission appliances, Crofts had intelligently anticipated the change-over, and belt, rope, chain and gear drives to meet the new conditions were at once available, whilst standardisation of proved appliances enabled quick delivery to be given of a range of drives to meet all general requirements. At the same time new devices for the more efficient transmission of power were regularly being introduced. Indeed during recent years patents have been acquired which cover almost the whole range of transmission appliances, the most outstanding of which are in connection with friction clutches of all types. These appliances included operating gears, flexible couplings, variable-speed gears, compression couplings, pressed steel pulleys, dust-excluding devices for plummer blocks, fan-cooled worm reduction gears, high-test iron castings, etc. The more recent of the patents granted may well be described as revolutionary in their application to power transmission and general engineering problems. We refer to the patent vee-rope variable-speed pulley which enables infinitely variable speeds to be obtained using vee ropes. The pulley can be mounted on any standard motor shaft, and the drive has the reliability and efficiency of standard vee-rope drives.

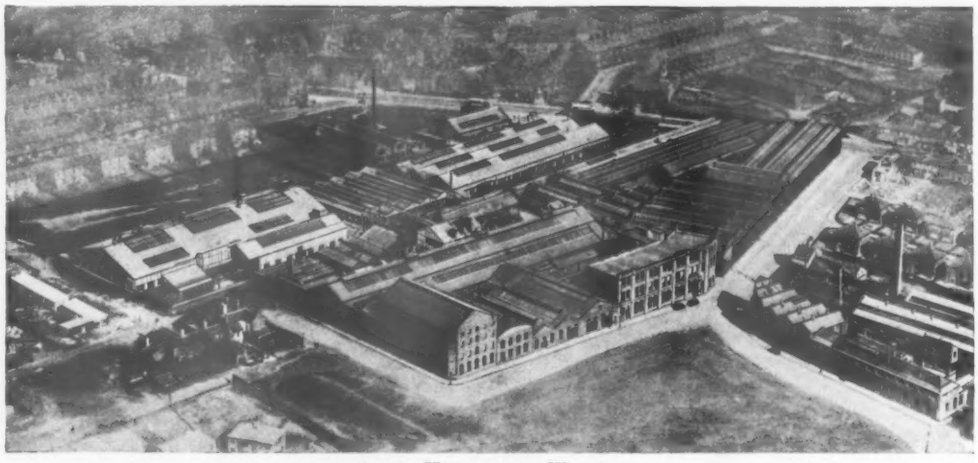
The operation of the variable-speed pulley is simplicity itself. Increase or decrease of speed is obtained through the operation of a hand-wheel, thus increasing or decreasing the centre distance between the driving and driven pulleys. At maximum centres the vee ropes are at the smallest pulley diameter of the variable-speed pulley, thus imparting the slowest speed to the driven pulley, whilst at the minimum centres the driven pulley is running at its highest speed, the vee ropes being then at the top of the variable-speed pulley. A coil spring is the medium which allows the pulley grooves to open or close automatically, and at the same time maintains the tension on the rope or ropes as the case may be.

In a modification of this type of pulley the springs are eliminated, and the position of the vee ropes in the variable pulley is adjusted to give correct speed by a screwed collar. For both types the motor may be mounted either upon slide rails or on an adjustable sliding base. With the variable-speed pulley speeds are variable up to 3 to 1 single or 6 to 1 for double drives.

Generally the vee-rope drive is becoming very popular for short-centre drives from electric motor to machine. It may be mentioned incidentally that Crofts have been making this type of drive for the past thirty years.

Another outstanding development of the later period is the geared motor in the design and standardisation of which Crofts were amongst the pioneers. Such a drive enables machinery, etc., to be direct coupled or otherwise as required at any desired speed, the motor and the gear box being combined as one integral unit, with ratios of speed reduction or increase to meet all requirements, whilst the range of standard units is from fractional horse-powers to upwards of 100 h.p.

The variable-speed gear is an interesting development of the variable-speed pulley, which is made in three standard types, open, enclosed and vertical.



AERIAL VIEW OF THE WORKS.

The construction of the gear is of the simplest possible form embodying the principle of expanding and contracting, driving and driven pullies, having wedge-section grooves of mechanically variable diameters, the mechanism being so arranged that as the belt tread of one pulley increases in diameter, the belt tread of the other pulley automatically and correspondingly decreases in diameter. Each pulley is formed of two cone-faced discs, the connection between them being a special design of flexible belt. The arrangement permits of infinite variations of speeds within a predetermined maximum and minimum being obtained immediately and, if necessary, whilst the machine is running.

A further recent development of particular interest is the firm's patented multiple-disc ball-operated clutch, in which pins and levers are dispensed with; it is designed more particularly for incorporation in all classes of machine tools, and with it easy and positive action is obtained without shock.

The Works

The works, except so far as the patternshop and stores are concerned, are housed on the ground floor, the shops being in three parallel lines with the stocking ground for steel bars, etc. Between them, the stocking ground is served by an overhead telpher system, runways from which extend into all the shops, so that handling is reduced to a minimum.

The patternshop and pattern stores are housed in a three-storey building, the ground floor of which is laid out for the patternshop, and is equipped with a full complement of the latest

types of wood-working machinery. The three upper floors serve as the pattern stores, all patterns being carried in numbered racks. From a consideration of the enormous number of patterns, one gets some idea of the endless variety of the company's productions. An annexe to the main pattern stores is laid off for the storage of metal patterns, whilst a separate store is provided for the patterns for gears and baseplates.

The main iron foundry is 400 ft. long by 90 ft. wide, and is covered by two bays. The main bay is served by three cranes of 20-ton, 10-ton and 5-ton capacities, whilst the gantries in the side bay carry two 2-ton cranes. The equipment includes a sand-slinger and 18 pulley-moulding machines. There are also two core machines. The core stoves and the three drying stoves are coke fired.

The melting plant consists of three cupolas, one of 8 tons and two of 3½ tons capacity respectively. They are fan blown, and have a common charging platform. The stocking ground, which is tandem with the charging platform, is served by a 2-ton crane, the runways of which extend over the charging platform. The charging skips are loaded on floor level, picked up by the crane, weighed on the charging platform, and then tipped into the cupolas. In this foundry castings up to 20 tons in weight are made.

Adjoining the main foundry is a foundry laid off for repetition work, the building being 120 ft. long by 90 ft. wide, metal being supplied from the main foundry melting plant. Plans have been formulated for the entire mechanisation of the smaller foundry. Thus, the moulding, casting and knocking out will be carried out on the most up-to-date mass-production lines.

The completion of this scheme will, however, be a work of time. The foundry is taxed to its limits to meet present demands, and for obvious reasons the change-over must be made without interference with daily operations.

Steel Foundry

The first steel foundry was laid down in 1920 for the production of high-quality steel castings by the electric process. Initially laid down to meet the demands of their own works, there was almost at once a demand from outside firms, which taxed the foundry beyond its capacity, and a new foundry was built with a floor space of 300 ft. by 150 ft., at the eastern side of the works. This foundry is covered by two bays. The main bay is served by two 10-ton cranes and one 5-ton crane, and the side bay by two 5-ton cranes.

Castings are made up to 6 tons in weight. A Sandslinger is in service, and in all there are 10 moulding machines. Lighter moulding and coremaking is done in the gallery, which extends along one side of the shop. The melting plant consists of two Héroult electric furnaces, each of 3 tons capacity. The annealing furnaces are anthracite coal and coke fired.

The fettling shop is conveniently placed, and is exceptionally well equipped with batteries of double-headed grinders, swing grinders, and a full range of pneumatic tools.

The non-ferrous foundry is generally equipped on standard up-to-date lines, but in addition there are centrifugal casting machines, which are used for the production of the highest quality phosphor-bronze worm-wheel rims and similar castings required for other of the company's specialities.

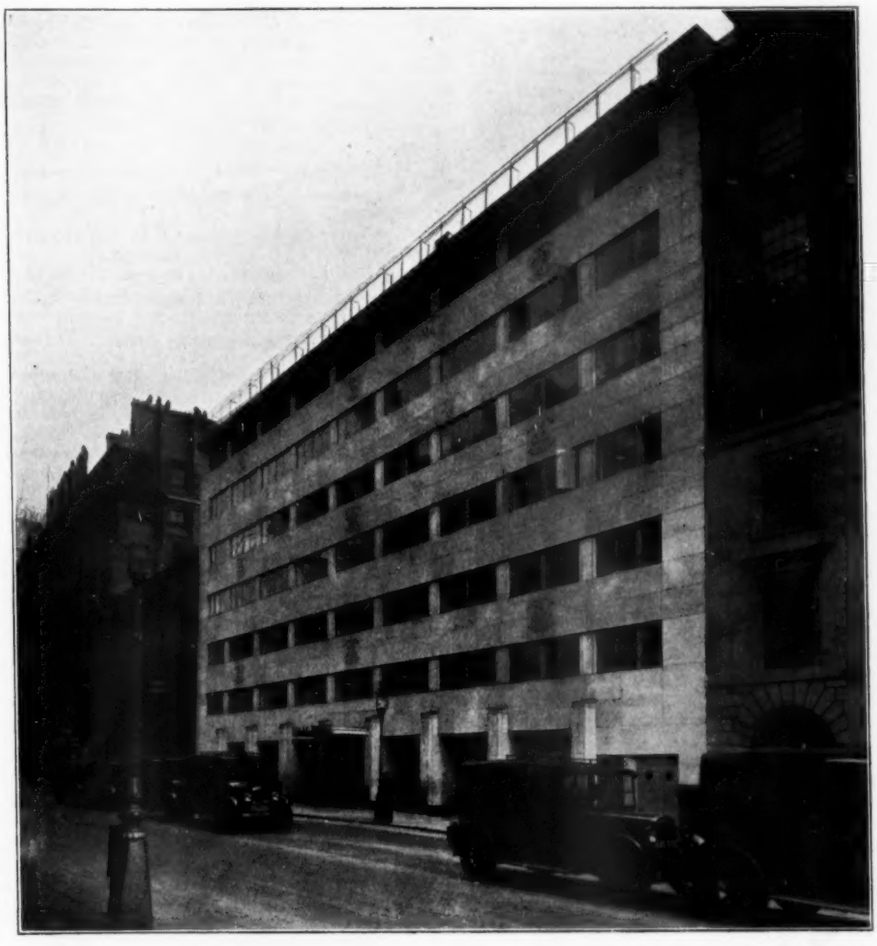
Crofts (Engineers), Limited, have very definitely given 50 years of unfailing useful service to industry, 50 years of really progressive development which has contributed in no small measure to raising the standard of power transmission machinery and appliances to the unquestionably high level it has now attained.

The British Iron and Steel Federation

NEW OFFICES AT STEEL HOUSE

As from March 1 the address of the British Iron and Steel Federation will be Steel House, Tothill Street, Westminster. As will be seen from the accompanying view of the new building it is of modern design and, although ceiling height may be rather limited, the windows are such as to afford the maximum amount of light. It may be of interest to recall that the National Federation of Iron and Steel Manufacturers, as it was first designated, was formed in 1918, and had offices in Temple Bar House, Fleet Street, until September, 1921, when they moved to Caxton House East, Tothill Street, Westminster. In 1934 the name was changed to the British Iron and Steel Federation, and its constitution was modified in accordance with the requirements necessitating the existence of a comprehensive organisation representing the whole industry and capable of negotiating international agreements.

In the new building will be housed the British Iron & Steel Corporation, whose export department has hitherto been located at Brettenham House, Lancaster Place, Strand, W.C.2. The National Association for Rolled and Re-rolled Steel Products will also have offices at Steel House, while the meeting rooms will be used for all meetings of Federation Committees, and also, when requested, for meetings of Affiliated Associations.



Book Review

Moderne Stahlgiesserei (The Modern Steelfoundry). By B. Osann. Published by Verlagsbuchhandlung Julius Springer, 22-24 Linkstrasse, Berlin, W.9. Price 26.70 R.M.

The book is divided into nine chapters, of which the first eight form a very complete description of the various methods of steel making employed in steel foundries, and of the properties of carbon and alloy steel castings. The author is to be congratulated on the thoroughness with which he has dealt with this aspect of steel founding.

The last chapter deals with the all-important phases of moulding, coremaking, precautions to take to counteract the effects of liquid and solid contractions, the cleaning and fettling of steel castings and their heat-treatment. It is, of course, impossible to cover such a vast subject more than superficially in the short space which the author has reserved for it in his book, and it is to be regretted, in the reviewer's opinion, that the author has not developed this last part of his remarkable book to the same extent as the first.

The book is very clearly illustrated; numerous tables and examples are given. It should prove invaluable, both for the student in metallurgy who wishes to acquire special knowledge of the difficult art of steel-founding, and also to the practical steel-founder. It is to be hoped that, for the benefit of British readers, an English translation will eventually be available. J. D.

Elements of Costing with Reference to Vitreous Enamelling*

By J. W. G. PEDDER, F.I.A.C., A.L.A.A.

Introduction

The subject of cost accounts has come to the foreground in recent years because of the increased interest in more accurate methods. Accurate methods are most essential to-day on account of the increasing specialisation in modern industries—one of which is vitreous enamelling. Many manufacturers are content with periodical trading accounts, but these in themselves are not sufficient to tell whether or not any one department is making a profit or running at a loss. The object of financial

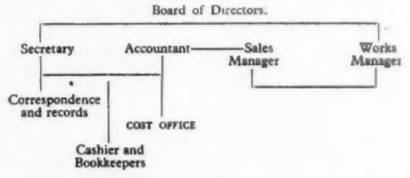


FIG. 1.—RELATION OF COST OFFICE TO THE ROUTINE OF A BUSINESS.

accounts is to obtain in the most direct manner the results of the transactions of the business with the business world outside. Contrast with this the manufacturer who wants to estimate for future work, having to regard each sale as a profit or loss according to the price he offers. In fixing the price he must not be so high as to lose the contract, nor so low as to lose his profit. The cost office will be able to tell the manufacturer exactly what his products or processes are costing him. From this information, presented in proper form, a manufacturer will be able to conduct operations on lines of the highest efficiency, thus obtaining the maximum product for the labour expended—not the same thing as the payment of lowest wages, but a minimum of unremunerative labour. The position of the cost office in relation to the routine of a business can be seen from Fig. 1.

For the efficient conduct of a business it is essential that there shall be complete co-operation between the works and office. It is hoped as the result of this Paper that those who are interested solely in the works side will appreciate the other side of their business and that a closer understanding will enable the works and office to work together to mutual advantage.

It is impossible to make any business fit into a ready-made costing system. The system must be adapted to suit the business, but the principles will be the same, and an endeavour will be made to outline these principles as they will appeal to the vitreous enameller.

A cost office is not cheap to run, and it is, therefore, most important that the information obtained from this department shall be accurate and available immediately. As this Paper is to deal with the elements of costing, as much accounting technique will be left out as possible. For the purpose of a general consideration of the subject it can be assumed that a "cost" is made up of (1) labour; (2) materials, and (3) establishment expenses. Each of these items can be sub-divided into:—(*a*) Direct items which can be allocated or charged to a specific article or process; (*b*) indirect items which cannot be charged direct to a specific article or process; and from them the selling price is built up in the following manner:—

Direct labour + Direct materials + Direct expenses = Prime cost.

Prime cost + { Factory indirect labour / materials / expenses } = Factory or works cost.

Works cost + Selling and administrative expenses = Total cost.

Total cost + Profit = Selling price.

Fig. 2 gives an idea of the flow of total cost:

From the vitreous enameller's point of view, two aspects of production can be considered. Firstly, the manufacture of the enamel, and, secondly, the application of the enamel, and both of these fall conveniently for the purpose of this Paper into the two broad classes under which all costing systems will fall. In fritting the work consists of a number of separate jobs, *i.e.*, the enamel is made in a series of batches, each of which is carried separately to completion and is the unit of work. In ascertaining the cost per pound of frit, one engages in job costing (developments of which are known as multiple costs and terminal costs). In the case

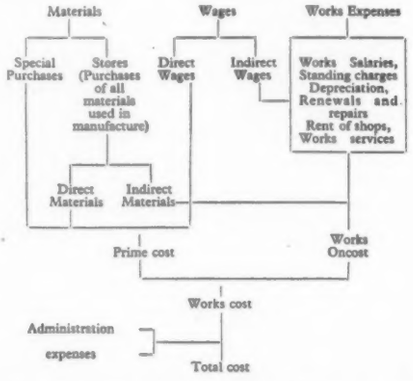


FIG. 2.—SCHEME SHOWING FLOW OF TOTAL COST.

of enamelling work, the various managements engage in process costing, since there are a number of processes, each depending on the other, concerned to enable them to finish their products, *i.e.*, milling, blasting or pickling, spraying, fusing and transport.

Fritting

In the first place, there must be a record of the output of the kilns. The form shown in Fig. 3 is one that is suggested for actual practice.

The cost of the raw materials is easily obtained and the frit weight is checked with the raw materials used. From the time taken to complete the smelting, wages, fuel consumption, wear and tear on kiln, rent, rates and taxes, and water can easily be calculated. The oil consumption will be known to be so many gallons

Melt. No.		
Date		
Material		
Fritted weight ..		
Time in		
Time out		
Melter		
Lifted by:		
Total weight of frit ..		
Cost of raw materials		

FIG. 3.—RECORD OF OUTPUT OF KILNS.

per hour (this should be checked periodically), wages will be taken on the rates paid to the men engaged on the frit kilns, and the other items can also be worked out on a time basis. Then for the amount of frit yield the following can be compiled from form:—

	£
Melt No 1, say, 1,000 lbs. Frit C.I. clear ..	
Raw materials	
Wages	
Fuel consumed	
Wear and tear of kiln	
Interest on capital	
Rent, rates and taxes	
Water	
Prime cost	
Indirect labour materials, per cent. ..	
Works cost	

This is a simple example of a job cost.

In practice, at the end of the account week, month or whatever accounting period may be desired, the totals of each item can be compared with the financial records, and they should agree, *i.e.*, the total wages appearing on the cost sheet summary should be identical with the cashiers' wages book, raw materials with stores requisitions and oil with fuel consumption. From the foregoing it will be seen that the actual cost of each variety of frit can be ascertained.

Milling

In the milling department, a similar procedure will be adopted. In Fig. 4 is a sample mill card that can be used. The cost of each particular variety of enamel can be calculated in the same manner as in fritting.

It is essential that the mill room be charged with the materials used at works cost. If a profit is added, a fictitious profit would be shown that would not always be realised. General expenses and selling costs are not, therefore, chargeable except as an addition to finished products when sold and despatched. Until any article is sold it is stock, and it is a very unwise man who, when stocktaking, adds a percentage to his cost as profit or part of the profit

* Paper read before The Institute of Vitreous Enamellers, Mr. V. C. Faulkner presiding.

he hopes he might make in the future. All work carried forward from one process or department to the next must, therefore, be charged at works cost. There is one exception to this rule, which does not apply to the enameller, but may be of general interest. Where many processes are involved and the finished product of one process is transferred to another process, and sales of each process are also effected, it is necessary to charge the following process at the lowest wholesale price. By this means it is possible to ascertain whether or not each process is worth carrying out. It may be found that it is more economical to eliminate one process and purchase in the open market the materials for the next process. Supplies of slop will be delivered to the spraying department against requisitions from the shop foreman, and from these requisitions and the frits drawn from the fritting shop the stock of milled enamels will be available.

DATE	MATERIAL
HRS. REQ.	
MILL STARTED	MILL STOPPED
FINENESS REQUIRED	
	LOADED BY
	UNLOADED BY
	COST OFFICE
	MATERIALS USED
	FRIT ..
	OXIDE ..
	CLAY ..
	OTHER ADDITIONS

Fig. 4.—Sample Mill Card.

In the case of blasting, castings can be formed into various groups on a weight basis or in some convenient units, and the cost of the units can be calculated in the following manner:—

	£
Power and lighting	
Depreciation	
Rent, rates and taxes	
Interest on capital	
Wages	
Oil and grease	
Renewals and repairs	

	Cwt.	Qr.	Lbs.	
Group 1 ..	„	„	„	Total weight
Group 2 ..	„	„	„	Total cost
Group 3 ..	„	„	„	
Group 4 ..	„	„	„	

In a similar manner, the cost of spraying and fusing can readily be obtained. The basis of cost of spraying should be taken on spraying hours. The cost of spraying is almost entirely time, *i.e.*, the men's time in carrying out the process and the time the power is running. The cost of spraying would be divided by the total number of working hours, *e.g.*, eight men spraying 50 hours per week would be a total of 400 hours.

In the same way, fusing costs would also be determined on a furnace-hour basis. The difference in weights of castings would be compensated for by the varying periods required to "run down" each fork load.

The author has now dealt briefly with the general outline of obtaining the cost of the finished products—not always "finished," inasmuch as they are complete, since frit from the frit house is a finished product as far as they are concerned, but only a "raw material" from the mill room point of view. The milled enamel is only a "raw material" as far as the sprayers are concerned.

As a simple illustration of the change and effect the introduction of a costing system will make, the following simple manufacturing and trading account, which is drawn up in the ordinary bookkeeping style, is submitted:—

Manufacturing and Trading Account for the Month ending January 31.

Dr.	£		Cr. £
To Stock	2,100	By Sales	12,000
„ Purchases ..	6,000	„ Stock	4,000
„ Wages ..	2,500		
„ Manufacturing charges ..	500		
„ Gross profit ..	4,900		
	16,000		16,000

Apparently: Purchases	=	50	per cent. Sales.
Mats. used	=	34.2	„ „ „
Wages	=	20.8	„ „ „
Charges	=	4.2	„ „ „
Profit	=	40.8	„ „ „

From the costing records it may be found that the stocks on January 1 were:—Raw materials, £900; finished goods, £1,200; and upon January 31:—Raw materials, £1,000; finished goods, £3,000. The following improved form of presentation of the accounts will show these figures in a different aspect:—

Raw Materials Account.

Dr.	£		Cr. £
Jan. 1. To Stock ..	900	Jan. 31. By Stock ..	1,000
„ 31. „ Purchases	6,000	„ 31. „ Mfg. a/c (Materials used)	5,900
	6,900		6,900

Manufacturing Account.

Dr.	£		Cr. £
Jan. 1. To Materials used	5,900	Jan. 31. By Finished goods a/c (Cost of finished goods)	8,900
„ 31. Wages	2,500		
„ 31. „ Expenses	500		
	8,900		8,900

Finished Goods Account.

Dr.	£		Cr. £
Jan. 1. To Stock ..	1,200	Jan. 31. By Stock ..	3,000
„ 31. „ Mfg. a/c	8,900	„ 31. „ Trading a/c (Cost of goods sold)	7,100
	10,100		10,100

Trading Account.

Dr.	£		Cr. £
Jan. 31. To Cost of Goods sold ..	7,100	Jan. 31. By Sales ..	12,000
„ 31. „ Gross profit	4,900		
	12,000		12,000

It will now be seen that materials constitute 66.4 per cent. of cost of finished goods; wages, 28.1 per cent.; and expenses, 5.5 per cent. of cost of finished goods.

For any particular job it is now evident that from the wages of materials used it is possible to determine the cost at once, *e.g.*, if £100 of materials are used, cost = £151. This information will be of the utmost usefulness to the producer, firstly, as a basis for his future operations and a check on his subsequent consumption of his various commodities. An increase in the percentage of raw materials will indicate either waste in production or increased cost of raw materials, both of which can be investigated and a suitable explanation obtained.

In the cost office a cost ledger will be used to obtain the figures given in the example in the following manner. Wages, purchases and expenses will be charged to each job account in detail, and the manufacturing account will be credited with the total. In the financial accounts the amounts expended will be charged to the manufacturing account and credited to the productive wages, purchases and expenses account. The manufacturing account in the financial books will then act as a control account for the cost ledger, for they should both agree on balance. In actual practice, however, it may be found that there will be a small difference. This is explained by the fact that expenses will be charged as oncost to individual job accounts as a percentage on wages and materials used, irrespective of the efficiency in the works methods, there will always be some waste, and there will generally be some slight difference in the pricing out of raw materials, especially where these are bought in the open market from time to time and not under long-period contracts.

Wages

One of the most effective means of ensuring a maximum output for money expended in wages is by a bonus to employees. It is a common fallacy that if one pays a man twice as much as a girl for twice the output, no material advantage is gained. On consideration, it will be agreed that a considerable saving is effected—overhead charges are halved on that particular job. Bonuses may be divided into three categories, *i.e.*, high wage plan, efficiency bonuses and profit-sharing. The high wage plan is self-explanatory. It is applied with the object of compelling employees to put the utmost energy into their efforts and enables employers to demand the highest possible standard.

Bonus Systems

There are several recognised systems of compensating the workman, and they are briefly described below. In the "Rowan" system, the bonus paid to an employee is fixed as a percentage on wage earned equal to the percentage of time saved. Under this method the workman will never earn double pay. Table I will give an example of the working of this scheme.

There are other plans which give a definite proportion of the time saved. The "Halsey" system gives 50 per cent. of the time saved, and the "Weir" system gives 33⅓ per cent. The previous computation on the "Halsey" plan is shown in Table II.

Tables I and II are particularly suitable for smelting frit where a time limit for the job can be fixed. Modifications of these schemes can be effected by giving the worker a graduated rate of bonus.

Profit-sharing schemes have for their object the stimulation of the employees' interest in the business, mutual elimination of waste, retention of employees' services by making them part proprietors, and improvement of methods, etc., by utilising employees' ideas. There are, however, a number of drawbacks to such schemes. The payments are usually too far apart and too small to have any material influence on the workers.

There is also the prevalent idea that employers gain far more from the extra efforts of their workpeople than is given back to them in the shape of profit bonus. It is also generally unacceptable owing to the fact that employees do not have access to the firm's financial records

and must take the amount of bonus for granted. There is also the objection that profit-sharing is the result of group effort. One department that was not run to best advantage would reap the benefit of other departments who worked efficiently. As far as possible, it is most advantageous that each man should have the benefit of his own effort to produce the largest amount of best quality work in the minimum time. It must be borne in mind, however, that in some cases it is group organisation that produces maximum output rather than individual performance.

Ordinary piecework rates need hardly be mentioned. It is essential that a proper record of the work turned out and passed by the inspection department is kept, and that there is no possibility of anybody being paid more than once for the same job.

Standard Costs

Standard costs represent the most recent and important advance in costing practice. The term "standard costs" is very loosely used, and is often connected with uniform or typical systems of costing for particular trades. Uniform methods have been introduced into many of the basic industries—printing, textile, and iron and steel, to mention but a few. The object of uniform systems in a particular industry rationalises costing procedure within the industry, whereby comparative statistics are easily available. Uniform systems are also very useful and effective in abolishing uneconomic competition due to misunderstanding or perhaps complete absence of costing principles. Budgetary control is very similar to standard costs as far as objective is concerned. In budgetary control, however, the output of a specific period is predetermined. By output, volume, cost of production and sales must be understood. The most economical cost obtainable is used as a basis, and periodically a comparison of actual and budgeted figures is made. The budgeted cost can then be revised if necessary for the ensuing period—some adjustment would be necessary by an unexpected variation in the level of output affected by, say, increased taxation on staple commodities largely used by the industry. Standard costs can be defined as the basic economic cost of producing an article or carrying out a process which can be used for measuring the degree of efficiency shown by actual costs.

In the absence of standard costs, efficiency can only be measured by a comparison of present costs with those of some previous period. The absurdity of such a comparison is obvious—the rapid improvements made in equipment in an enamelling plant alone make it impossible to say that one year's cost of production is in any way comparable with the previous year's. Take this a step further and examine labour-cost variations. It is not much use merely saying that wages or labour cost is excessive; the cause should be made clear. This may be due to the fact that the time taken is longer, an increase in the rate of pay, or both. It will also be realised that labour cost may not change due to the fact of time saved being offset by increased rates of pay. With the application of a wage incentive method of payment, increasing rate of pay should indicate efficiently the result of saving time. Where straight piecework rates are in use, some people are of opinion that no further control is necessary, as the worker is only paid for what he does. The time factor, however, is still of vital importance. For example, a blast might cost more to run than the value of the work turned out per man-hour. An increase in time, although not accompanied by an increase in cost per unit of output, will result in overheads being increased. Increases in time as distinct from rates should be investigated, as they may be the result of dilatoriness on the part of the employee due to causes either within or outside his control. Material cost variation can also be considered on the cost of purchase and consumption. Overhead cost variations can also occur within and outside the control of the works. The preparation of suitable cost standards will depend largely on personal experience. The first consideration is the basis of output. The normal output should represent the capacity to manufacture and to sell. Past experience may here be of some assistance, but the estimator should have a prospective rather than retrospective outlook.

Table I.—"*Rowan*" *System of Compensating Workmen.*

Time allowed: 10 hours. Wage rate: 1s. 6d.	Time saved.	Per cent.	Wage earned.	Bonus.	Total wage.	Rate per hour.	Employer saves.
			s. d.	s. d.	s. d.	s. d.	s. d.
Work completed in 8 hours..	2	20	12 0	2 5	14 5	1 10	0 7
Work completed in 7 hours..	3	30	10 6	3 2	13 8	1 11	1 4
Work completed in 6 hours..	4	40	9 0	3 7	12 7	2 1	2 5

Spare Plant

It will be readily appreciated that the maximum capacity of any plant can never be realised in practice. To say the least, it would be impossible to have every department working at its utmost capacity. That would mean that every departmental process, where the departments are interdependent, as in an enamelling plant, would be readily absorbed by that following—an ideal one endeavours to attain but rarely does. Any foreseeing enameller will know the necessity of having standby plant in case of breakdown. All this spare plant represents possible production, but must be considered as idle plant. It is, however, necessary to obtain a theoretical estimate of the total output on the lines previously mentioned, so as to include all capital in use and make allowance for idle time. This allowance will be based on the proportion of plant held as standby in relationship to the whole, *e.g.*, one kiln idle and one kiln in use would represent 50 per cent. idle time, but one kiln standing by out of ten would only represent 10 per cent. Overhead cost standards will not be so readily established. There are some overheads that are incurred irrespective of the volume of output and must be considered fixed—for example, rents and rates. Then there are those which are variable, but do not fluctuate proportionately with variations in output, *i.e.*, administrative expenses; and there remain those which vary directly with output. From this it will be seen that two levels are possible—an operating level and a spending level. Assuming a theoretical standard of 100 per cent. for both operating and spending levels, it might be possible to compile a table similar to the following:

Table II.—"*Halsey*" *System of Compensating Workmen.*

Time allowed: 10 hours. Wage rate: 1s. 6d.	Time saved.	Wage earned.	Bonus half time saved.	Total wage.	Rate per hour.	Employer saves.
		s. d.	s. d.	s. d.	s. d.	s. d.
Work completed in 8 hours	2	12 0	1 6	13 6	1 8	1 6
Work completed in 7 hours	3	10 6	2 3	12 9	1 10	2 3
Work completed in 6 hours	4	9 0	3 0	12 0	2 0	3 0

Operating level. Per cent.	Spending level. Per cent.	Loss due to idle time. Per cent.
100	100	none
80	90	10
60	80	20

From such a table it will be possible to watch overhead expenses and exercise particular control as the output from the plant diminishes. In other words, in slack time overhead expenses must be more carefully investigated. These expenses must be carefully analysed and allocated to each department, and, where expensive plant is used in a department, to each machine unit. With regard to wages cost standards, the introduction of one of the incentive bonus systems already mentioned, whether or not the output is maintained at one efficient level, will be apparent at once. Immediately the rate of pay falls below that fixed for the job (in the examples shown, less than 1s. 6d. per hour), the wages are not economic.

Material cost standards may not at first appear to be so easy to establish. With the variations that occur from day to day in the open market for various commodities an average possible price must be determined. On the other hand, with present-day tendencies to enter into long-term contracts for supplies, the matter becomes very much easier. In the presentation of results, the variations are expressed in relation to the standard of 100, from which an index of efficiency can be immediately apparent. Table III shows a manufacturing and efficiency operating statement.

Table III.—*Manufacturing and Efficiency Operating Statement.*

	Manufacturing.			Efficiency.	
	Standard	This month.	Last month.	This month.	Last month
Labour:—	£	£	£	£	£
Rates ..	6,000	5,900	6,100	98	102
Idle time	100	50	75	50	75
	6,100	5,950	6,175	99	101
Material:—					
Price ..	10,000	10,500	9,500	105	95
Mechanical loss ..	100	100	75	100	75
	10,100	10,600	9,575	105	95
Overhead ..	2,000	2,100	1,900	105	95
Total mfg. cost	18,200	18,650	17,650	102	97

Assuming the operating level was the same in each month, the efficiency figures speak for themselves.

Profits

On previous occasions the question of interest on capital and profit have been raised. It will be clear that, if the return from running an enamelling plant was equal to the yield obtained from gilt-edged securities, the proprietors would invest their money in the latter and obtain the same return for their money without the trouble of working for it. Each department employing some of the company's capital must, therefore, charge itself with this amount. It is also hardly fair that one department should make use of three-quarters of the company's capital and the others only one-quarter without some contribution or compensating load for the use of the company's funds. Any remarks on profit are really outside the scope of this Paper, but as a matter of general interest the real profit of a business cannot be determined until the business is wound up.

(*Concluded on page* 204.)

Mechanical Drying in Vitreous Enamelling*

By J. H. HOLLOWS

A mechanical dryer may be defined as a machine insulated from the atmosphere, and containing equipment for maintaining the drying air at a suitable temperature, and for circulating that air in an efficient and controllable manner. A heated room, with no air circulation beyond that inspired by convection or a simple exhaust fan, is *not* included in this definition. These warm stoves or drying lofts, which still have many adherents, usually consist of brick or asbestos-enclosed rooms, heated by means of steam coils, furnace exhaust gases, coke or coal furnaces, or a combination of two of these methods.

The temperature inside the rooms varies between 80 deg. and 100 deg. Fah. Sometimes exhaust apertures are provided for the egress of the saturated air, and in other cases an exhaust fan is fitted. The time required to dry wet enamelled articles varies between one and 24 hrs., depending on the type and size of the load. The advantages claimed for this system are varied, depending on the conditions peculiar to the particular works under consideration; but an advantage common to all is the comparatively low initial cost. The principal disadvantages inherent in this class of dryer are:—(1) Long drying time, in some cases resulting in faulty finish; (2) large space required; (3) low thermal efficiency; and (4) risk of contamination by dirt, due to the ware lying in a damp condition for long periods in an atmosphere having uncontrollable air currents.

Principles of Drying

In practice, air movement is essential to the process of drying; heat is merely an accessory which decreases the drying time by increasing both the rate of evaporation and the absorbing power of the surrounding space. The surrounding atmosphere is universally recognised as the best medium for the absorption and removal of moisture; for instance, if air at 52 deg. Fah. is heated to 72 deg. Fah., its capacity for absorbing moisture is doubled. Air is saturated when it becomes incapable of taking up and holding invisibly any additional amount of vapour; but saturated mixtures of air and vapour are seldom to be found either in nature or in connection with a properly-operated drying system.

Maximum Economic Drying Temperature

There is some controversy concerning the maximum temperature permissible in the drying of vitreous enamel. Temperatures ranging from 80 to 450 deg. Fah. have been put forward as ideal. From data collected from various sources and from personal experience, it seems increasingly obvious that high temperature in itself is not detrimental to good drying. This statement is made with reservation concerning the delicate colours used in certain work, and other special cases. Using a direct-fired dryer at a temperature of 450 deg. Fah., flat sprayed sheets have been dried experimentally in 2½ min. On the other hand, a swilled sheet, about 2 ft. wide, bent across the centre line at right angles over a radius of approximately 2 in., has cracked off the enamel on the radius corner when dried in 5 min. at a temperature of 220 deg. Fah.

These two points illustrate that the limit of temperature which can be used safely is dependent on the formation of the enamelled article. It is, therefore, necessary to determine what maximum temperature it is most *economic* to use, and whether this temperature will be safe for the majority of cases. To do this the mechanics of the dryer employing temperatures from 350 to 450 deg. Fah. must be examined. A dryer to take a reasonable amount of work and maintain a competitive thermal efficiency running at this figure would need to be directly fired. This means that the combustion gases would come into direct contact with the wet enamel. The heating energy required would most likely be provided either by coal, gas or heavy oil. Unless combustion was carefully controlled, sulphur fumes, carbon, or both, would be present in the combustion gases, and under any circumstances the risk of contamination of the enamel would be fairly high. In America, and to a very much smaller extent in this country, direct-fired dryers *are* used on certain work; but the general feeling here is that the risk of contamination is too high. Referring again to the experimental drying time of 2½ min. at high temperature on flat sheets, under actual working conditions, this time is considerably increased. It is possible, by suitable air circulation, to equal the best working drying time of the high temperature dryer, but using air at a temperature around 200 deg. Fah. At this lower temperature one can employ air circulation which would be difficult to achieve at high temperature; what is more important, an indirect-fired dryer can be used. This dryer involves no risk of contamination due to combustion gases, and has the same thermal efficiency as the direct-fired high-temperature dryer and gives the same drying time. There is no apparent reason, therefore, to suggest dryers with a maximum temperature of more than 220 deg. Fah. From tests made to fix a minimum temperature suitable for any formation of article, 150 deg. Fah. has been found to be a safe figure, except for those cases in connection with delicate colours and special work.

Heat Generation

Discrimination between the various means in use for generating heat is governed by two main points. The first is the relative cost of operation, having regard to the various circumstances peculiar to the works involved. If gas or oil be used for muffle furnaces, the contract price of the gas or oil is usually such that these fuels can be used economically for the drying equipment. If an adequate steam supply already exists, this also must be considered. The second main point is the ease of application and control of the heating medium chosen. This leads up to the case of furnace waste gases for heating the drying equipment.

A highly controversial question in connection with drying in vitreous enamelling is whether or not to use the waste heat from the muffle furnace. The reason for this controversy is not far to seek, when, on the one hand there are thousands of B.T.U's. escaping through the furnace flues, and in the other corner of the shop there is sometimes quite costly and elaborate plant for generating the heat necessary for drying purposes.

The muffle furnace being probably the biggest consumer of fuel in the whole enamelling plant, it is necessary that the efficiency be kept as high as possible. In order that the heat from the waste gases can be utilised for drying, some form of heat interchange must be provided. The fitting of this interchange gear to the furnace tends to lower the efficiency of the furnace. Also, it is doubtful whether sufficient heat can be taken from the gases of one furnace to dry successfully the amount of enamelled ware necessary to keep that furnace working continuously. Consequently, some auxiliary booster is often required to keep up the output of the dryer to equal that of the furnace. Alternatively, additional heat interchangers can be fitted to the furnaces, but with each addition the efficiency is impaired.

Heat Interchangers

The heat interchangers sometimes cause trouble, due to the combustion gases leaking into the drying air and causing contamination of the enamel which is being dried. The risk of a burn-out of the interchanger can be reduced somewhat if it is arranged to deliver a proportionately large volume of air at medium temperature rather than a small volume at high temperature. This adjustment cannot be carried out indefinitely, as the more the working temperature of the interchanger is reduced, so is the efficiency reduced. If the conditions prevailing when an interchanger is used be examined further, it is found that the air delivered has a very low relative humidity.

It is a peculiar fact of drying technique that the best drying occurs when fairly humid air is used, particularly during the initial stages. Consequently, air delivered from a heat interchanger is not quite so suitable as might be thought. Also, the air needs to be mixed with cool air in order to reduce the temperature to one suitable for circulation in the dryer. This is comparatively easy, but what is important is that control of temperature in a compact dryer using this method cannot be accomplished simply. If automatic temperature control is considered necessary, the problem becomes even more involved.

It is probable that the saving in cost of fuel resulting from the utilisation of waste heat does not compensate for the lowering of efficiency of the furnaces, the risk of contamination of the enamel and the difficulties in providing simple control and humid conditions in the dryer itself.

Relative Merits of Fuels

By means of efficient heating batteries, it is possible to utilise steam at any pressure, either live or exhaust, to raise the drying air to the comparatively modest temperature required (150 to 200 deg. Fah.). The best type of battery is probably that composed of steel-gilled pipes, welded into a compact and sturdy formation With this form of construction there is little chance of steam leakages in awkward and inaccessible parts of the machine, as there are no joints except the inlet and outlet to the battery, and these are usually made outside the body of the machine. In addition, because of the compact construction, the battery can be fitted into the machine in such a position that the circulating air can be directed through the battery quite easily, so that an efficient heat exchange is obtained.

For the control of the batteries, an ordinary wheel valve is all that is usually required. With steam at normal working pressures, it is safe to use the machine without automatic temperature control, as it is unlikely that any dangerously high temperatures can be reached, should the steam supply be left on whilst the machine is taking a light charge. It is possible to modify this type of heater for use with gas. The gilled pipes are then brought out through the walls of the machine and immersion-type gas burners arranged to burn through the pipes. The free ends of the gilled pipes are connected to a suitable fume duct, the combustion gases being exhausted through this duct by means of a fan.

Automatic control of temperature should be provided with this form of heating, as high temperatures may be reached quite quickly in the event of the machine working on light loads. Thermostatic control of gas burners is fairly simple and comparatively cheap, and operates very satisfactorily.

Oil Fuel

To apply oil firing to this type of dryer, the same principles of heat interchange can be used,

* A Paper presented to the Northern Section of The Institute of Vitreous Enamellers.

but the construction is somewhat different. It is usual to use heavy fuel oil of about 200 secs. viscosity. A common combustion-chamber construction should be employed, having only one burner which could be fitted with thermostatic control. The products of combustion would then pass to the heater elements, and, if necessary, a certain amount of dilution of these products could be obtained by means of secondary air dampers situated in the front of the combustion chamber on each side of the burner. So long as this combustion chamber is suitably insulated, the heat losses can be cut down to a minimum.

Relative Costs of Steam, Gas and Oil

In the case of steam, using a reasonably efficient boiler (60 per cent.) and coal at 25s. a ton, an approximate cost of 0.01675 pence to supply 1,000 B.T.U's. of heat energy is obtained. As the prices of both oil and gas vary considerably throughout the country, the author has, in order to arrive at some basis for calculation, assumed that gas can be obtained at 1s. per 1,000 cub. ft. and at a calorific value of 500 B.T.U's. per cub. ft. The average price of heavy fuel oil, when compared in terms of heat units, is approximately the same as gas at the above price. The price for gas and oil, therefore, on the above basis, works out at 0.024 pence for 1,000 B.T.U's.

Air Movement

Air movement is one of the few unstable facts in the study of drying technique, for it has not yet been possible to reduce this technique to an exact science. Considerable research has taken place on the Continent and in this country in connection with this, and, as far as can be gathered, the important fact emerges that turbulence rather than stratified air conditions gives the quickest and most even drying, all other conditions being equal. Unfortunately, the general shape of enamelled pieces to be dried is usually built up of flat surfaces, which naturally cause the air in many dryers to take up the stratified conditions which it is desirable to obviate.

The dryers included in this class are the conveyor type, using either parallel or counter current drying air, and the chamber type, with air entering and leaving at the top and bottom of the dryer respectively. Considering the conveyor type first, the drying tunnel usually is of comparatively small cross-section, just sufficiently large to take the largest piece of work. The pieces are progressed through the tunnel on a mechanical conveyor, and the length of the tunnel is determined by the drying time and the output required.

Air is heated to the required temperature by means of a heating battery situated outside the tunnel, and by means of a fan the heated air is introduced into one end of the tunnel, passed once along the length of the tunnel, and then either exhausted to atmosphere or recirculated through the heating battery and again through the tunnel. In the latter case, it is necessary that a certain amount of the air be exhausted, and fresh air brought in to replace it, so that the drying air does not become saturated. With this method of air circulation, the drying air cannot be in a condition of turbulence. Further, as the air passes quickly once along the length of the tunnel, it is not exploited fully, nor does it attack the wet enamel when it is in a condition of high relative humidity. Another fact tending to reduce the thermal efficiency is that, because the heating battery is outside the drying space, and the air is fed to and from the battery by means of ducting, some losses due to radiation may be expected.

The humidity of the drying air is an important factor. If hot dry air be applied to the enamel when it is in its wettest condition, a very thin, but perceptible dry skin tends to form on the enamel surface. As drying continues, and the inner layer of wet enamel gives up its moisture, the dry outer layer is fractured, and a faulty finish results. It is necessary, therefore, that the enamel be increased in temperature right through to the metal before an appreciable amount of moisture has been given off by the enamel. To this end, the drying air which attacks the enamel during the initial drying stage must be of high relative humidity.

When the enamel is sufficiently hot, and yet still quite wet, it is possible to use air containing less moisture and the water in the enamel can then be extracted quite quickly. In the conveyor dryer with the parallel current air circulation, the drying air has not time, during its single passage through the tunnel, to pick up the necessary moisture and increase sufficiently its relative humidity.

Chamber Machines

The same loss of thermal efficiency may be expected in chamber machines, due to the air being heated outside the drying chamber and then introduced into the chamber from either the top or the bottom. Moreover, stratified air conditions are likely to obtain due to the straight through-passage of the drying air. Similarly, the moisture content is likely to be low, although in *any* chamber machine it is difficult to achieve the desired conditions, unless the system of working in the enamel shop allows of movement of the drying articles whilst in the chamber.

It would appear that a drying machine, to be as efficient as possible, should have turbulent air currents at varying degrees of humidity and pressure for the drying air, and arranged so that the heating elements and fans are inside the walls of the machine.

Effect of High-Pressure Air on Wet Enamel

It has been found, particularly with swilled ware, that when the enamel is in its wettest condition, circulating air at certain values of pressure causes the enamel to be disturbed on the metal and produce a rippled effect. It is, however, necessary to employ these values of pressure to produce efficient drying and to overcome the resistance of the pieces which are being dried. These two facts suggest that some variation of the air currents is necessary during drying, so that air at medium pressure attacks the enamel during the initial stage, and as drying progresses the pressure is increased to take full advantage of the air circulation.

Construction of Conveyor Machine

A conveyor machine designed to produce all these conditions and arranged to take pieces on trucks can be constructed in the following manner. The drying space, or tunnel proper, is built on a framework of mild steel angles and channels, on each side of which is fitted steel sheeting. The cross-section of the tunnel is of a size which will accommodate one or two lines of trucks, with very little clearance round them. This latter point is important. In each of the two sides of the tunnel adjustable louvres are provided.

The whole of the tunnel is then enclosed in a second framework of mild steel, leaving a clearance of, say, 2 ft. between it and the drying tunnel. Suitable heat insulating material, enclosed in sheet steel plates, is built up on to this outer framework. Heating batteries are situated in the spaces along each side of the machine, between the inner and outer walls of the tunnel; these spaces can be termed the heating compartments. Air circulation is obtained by means of a series of centrifugal fans arranged along each side of the machine. The shafts of these fans are at right angles to the length of the machine, and are situated at six or seven feet centres along the top of the heating compartments, above the batteries.

Exhaust apertures are provided near the feed end of the machine, and are of such size that when fully opened, they will allow to be spilled to atmosphere about 10 or 15 per cent. of the air circulated by one pair of fans. Propulsion gear is fitted so that the trucks can be progressed through the tunnel intermittently, as the need arises. It is usual for doors to be provided at each end of the machine. By means of this construction the turbulence necessary to efficient drying is present to a marked degree.

Movement of Air in Machine

Air is drawn into the top of the machine at the delivery end by means of the first pair of fans, one on each side of the machine. It is delivered from the fans, down through the respective heating batteries in the side compartments, and enters the drying tunnel proper through the side louvres. The bulk of this air covers a semi-circular path across the tunnel, is drawn to the top of the machine and recirculated again by the same first pair of fans. A proportion of the air is spiralled along the machine to the second pair of fans, entering these at the top of the machine and being circulated through their respective heating batteries and across the machine in the same manner as by the preceding pair of fans. This sequence continues along the full length of the machine.

Each pair of fans, and their concomitant heating batteries, can be termed one zone of the machine. By reason of the air in each zone being moved in a semi-circular path across the machine, there is at once created a condition of turbulence. Added to this is the fact that a proportion of the air is being spiralled along the machine, from one zone to the next. Therefore, as the trucks are progressed through the machine, the work being dried is subjected to a continually changing set of turbulent air conditions, which is almost ideal from a drying point of view.

The amount of air being passed from one zone to the next is governed by how much air is being exhausted from the machine. It has been stated that when the exhaust aperture is fully open, the amount of air which can be spilled to atmosphere is only 10 to 15 per cent. of the air circulated by one pair of fans. Allowing for leakages, due to door openings, etc., this figure will be increased to approximately 25 per cent. It will thus be readily appreciated that the thermal efficiency of the machine can be kept quite high, as the air in the machine is being used to its full advantage. Indeed, theoretically it is only necessary to exhaust sufficient air to keep the air in the final zone a little below saturation point. This means that in the intermediate zones between the first and the last, very little heating surface is required in the batteries.

The temperature gradient through the machine can be governed within reasonably fine limits by adjustment, during design, of the heating surface, and the pressure of the circulating air can be suitably adjusted between adjacent zones.

Humidity

Because the drying air is recirculated in contact with the wet enamel, and progressed slowly along the machine, by the time the air reaches the final zone (which is at the feed end of the machine), its relative humidity is high. This is the condition required, as is also the fact that the humidity is proportionately lower, zone to zone, as the enamelled articles travel through the machine, from the feed to the delivery end. Due to the shape of the articles being dried, it is sometimes necessary to reverse the direction of the air currents in alternate zones, which is easily accomplished by arranging the fans at the bottom of the machine, underneath the heating batteries in the zones requiring this reversal of air currents.

It can be assumed from the foregoing that ideal drying conditions can be most easily obtained in a conveyor or tunnel type machine, arranged to take the enamelled pieces on trucks. These conditions can be duplicated in a tunnel dryer of small cross-section by carrying the pieces through the tunnel on a conveyor belt, fitted with arms or trays each to take one or two pieces. The length of the dryer for a given output is greatly increased if this system be adopted, but due to the comparatively small

(*Concluded on page* 202.)

STANTON-DALE
REFINED PIG IRON

Three typical analyses

	Total Carbon	Silicon	Sulphur	Phos.	Mang.
Motor-car cylinders	3	1·8-2·2	·05	·3	·5
Hydraulic Work	3·2	1·5-1·8	·07	·4	·5
Gas and Marine cylinders	3	1 3-1·6	·07	·5	·5

Stanton-Dale is a low total carbon pig giving close-grained, grey iron castings of great strength and toughness. Seven standard grades are available, and we can also supply to customers' own requirements without extra cost.

The Stanton Ironworks Company Limited, Near Nottingham

The Largest Producers of Foundry Pig Iron (for sale) in Great Britain

cross-section, the dryer can be slung from roof girders, at sufficient height to allow of the free passage of operatives underneath the dryer. In this way valuable floor space can be saved.

Turbulence in Chamber Machines

The desirable condition of air turbulence can be produced in a chamber machine provided the chambers are not too wide. A width of eight to ten feet is a useful size. The same construction as described for the tunnel machine can be used, so that an inner chamber is enclosed by an outer, insulated carcase, the fans and heating batteries being disposed in the heating compartments along the two sides of the machine. The air in this machine is recirculated continuously in each separate zone, separate exhausts being provided for each zone. The humidity of the drying air is arranged to reach a medium value of saturation; of course, this cannot be varied during the drying period. It is desirable, also, that the temperature be slightly lower than the highest obtaining in a tunnel machine dealing with similar work.

Enamelled pieces can be accommodated in the chamber, in any convenient manner, and doors are usually provided at each end of the machine. Using a chamber machine of this type, a convenient method of operation is to charge the machine with the heat turned on, but without the fans running. This prevents dust being introduced through the doors while they are open during charging, and the operatives entering the machine are not subjected to blasts of hot circulating air. When the machine is fully charged, the doors can be closed, the fans started, and the whole charge dried in a few minutes' time. The drying time, when working with this system, is very short, as the static air in the dryer with the fans stationary is quite hot, due to the heating batteries being inside the machine. Consequently, a certain amount of moisture is extracted from the enamel before the machine is closed and the fans started up.

It can be said generally of chamber machines that the most efficient system, from the standpoint of drying and thermal efficiency, is to use a number of small units rather than one large chamber. Whether this is practicable or not depends to a large extent on the works layout, and the types of pieces being enamelled. In the case of cast iron, it is important that the enamelled pieces be placed in the dryer immediately they have received their coating of enamel. A useful type of dryer for this duty is a chamber machine, one zone in length. Each end is fitted with a number of horizontal doors, hinged along their upper edges, and opened by means of levers at the side of the machine, the doors being counterbalanced to allow of easy operation. Each door gives access to a suitable rack and the work can be introduced into each separate rack at one end of the machine and taken from the machine when dry at the opposite end.

This layout allows the machine to be continually opened to receive pieces as they are dipped or sprayed, but the relatively small door opening does not allow too great an amount of heat to escape. One small dryer is needed for every one or two spraying booths or dipping tanks.

Modified Methods

A modification of the tunnel dryer, and one which can be called a chamber machine, has proved very useful for various classes of work. This is merely a short tunnel of two zones length arranged to take two lines of trucks, the maximum number of average-sized trucks which can be accommodated in the machine being six. In this machine two sets of conditions are possible in the air currents and humidity, and consequently it is possible to get good all-round efficiency. It is also possible to dispense with the propulsion gear of the trucks, as it is comparatively easy for the centre truck on each side of the machine to be pushed forward by the one immediately behind it.

Another modification of the tunnel machine, which takes up very little floor space compared with its output, is a three-zone machine with two hand-operated conveyor bands, one above the other. This machine is particularly suitable for cylindrical or rectangular sheet-steel casings. The casings are carried vertically on the two conveyor bands and the output of such a machine working on swilled sheet is approximately 2,700 sq. ft. of sheet per hr., enamelled both sides. The floor space required is approximately 18 ft. by 10 ft.

Drying after Pickling

For this operation there is one important difference, and that is that high temperatures seem to be essential. The reason is that the surface moisture on the sheets is usually more or less evaporated before they are placed in the dryer. It is, however, essential that the pools of water resting in any crevasses or hollows in the sheets should be removed, and to do this quickly the temperature of the metal must be raised very quickly, and so more or less boil out the water. Consequently, temperatures in the region of 400 deg. to 450 deg. are the most useful. To ensure that all parts of the drying space are at an even temperature, turbulent air conditions are necessary, and to keep the thermal efficiency of the machine high, the heating batteries should be inside the walls of the machine.

It is not advisable to use the same dryer for the pickled sheets as is used for the drying of the enamel prior to fusing.

The technique of drying discussed has been developed from principles first used on the Continent.

Conclusions

An efficient dryer for general vitreous enamel work should embody as many as possible of the following points:—(1) Turbulent air conditions; (2) drying air of relatively high humidity; (3) at least two different sets of air conditions; (4) temperature inside the dryer between 150 deg. and 200 deg. Fah.; (5) indirectly fired, if gas or oil is used; (6) dryer to be as small in size as is possible; (7) tunnel type of machine wherever possible, and (8) heating units to be within the walls of the dryer. With some work, a number of these conditions are not possible of achievement, but as many as possible should be looked for, and turbulence, it is suggested, should be insisted upon.

The author desires to express his thanks to the directors of Tomlinsons (Rochdale), Limited, for their permission to present this Paper.

Metal Degreasing

In connection with the Paper by DR. N. R. HOOD on "Metal Degreasing Prior to Vitreous Enamelling," which was read before the Southern Section of The Institute of Vitreous Enamellers recently and published in our February 4, issue, MR. E. A. JOHNSON writes:—The first section of the Paper dealing with alkaline cleaners did not mention the adoption of other agitation besides the mere boiling of solution, therefore, for any plants operating with air agitation or very vigorous boiling, personal experiences with the additions of soapy compounds to a solution are given below.

If one adds soap without due care, thereby causing too high a concentration, excessive frothing takes place which, in turn, does not permit the usual economic skimming off of grease by allowing the solution to be made up to its overflow level. Instead the froth supports the grease and scum in rather concentrated form, and being comparatively lighter does not flow with the same rapidity as the solution over the fall. It can be followed, therefore, that this concentration is objectionable for work being withdrawn, as it causes the re-deposition or trapping of grease previously removed. However, this appears to be released in subsequent agitated water rinse, but should the work be in a very greasy state before operating, it does make this scum sufficiently objectionable, in so much that it gets carried into the rinse, this is not so noticeable where alternate rinses are employed. This is chiefly encountered where skimming has to be done several times a day whilst permitting a continual stream of production to flow through the plant.

The same argument is often put forward for soap-free alkaline baths; this is quite true, but as the surface of solution is broken with the withdrawal of work, it divides the mass, and with steady boiling solution a fine scum can be seen to be parting up to ½ in. from the actual surface of the article. This does not hold for flat sheet work, as the solution is only divided by the uppermost edge, after which the scum closing in causes streaking to result. Now with excessive frothy solutions the laden froth falls towards the work continuously, because of its sluggishness in following the course of the solution beneath it. Therefore, excessive frothing should be closely guarded against.

Several complaints are made about most alkaline cleaners failing to do what is expected of them, and there is no doubt that to get gratifying results one must reduce the concentration of grease for such cleaners to saponify or emulsify, or to clean and leave clean the work passed through them.

This has been attempted, as disclosed in the Paper, by the use of petrol, or some non-inflammable solvent. There are several ways for any of these to be adopted, *e.g.*, complete immersion of work into a tank or vat containing pure spirit, others are by wiping the work with spirit laden rag, brush or sponge. Personal experience is that none of these will give a really satisfactory result, though in many cases it is the only possible means of preparing a base surface prior to other processes, and one must not completely exclude them. Generally speaking, however, this method should be laid aside for the adoption of the most economic, though by its face value, the most costly of cleaning processes.

The following is a comparison well worth while considering:—

Firstly, what does the vitreous enameller require and waste with spirit cleaning? In the case of a spirit bath it becomes heavily laden with grease, in fact from the first insertion of work into it, it no longer remains neat spirit. Further, there is loss by drag out and splashing, excessive floor space is required, labour is costly, and there is an excessive mess. The wiping procedure is just as bad; rags, brushes and sponges all cost money and wear out. Much spirit is wasted, floor space and labour costs are augmented, and, most important of all, these methods only reduce or spread out the concentration of grease proportionally to the cleanliness of the spirit and materials in use. Such contamination does not afford the maximum cleanliness desirable, hence rejects often result due to the imperceptible amounts of grease present.

There is only one economic method, and that is trichlorethylene degreasing. For this, one requires floor space, probably quite as much as with spirit cleaning, and additionally some method of heating has to be installed. What does one save?

(1) As Dr. Hood suggested, the trichlorethylene itself, and it might be added, a very great proportion in comparison with cleaning spirit.

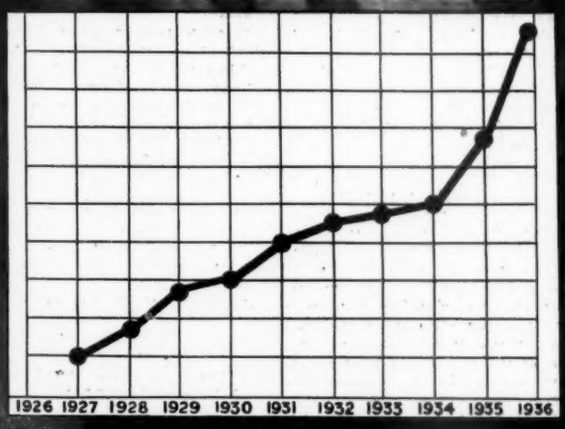
(2) Lower labour costs are obtained because wiping is unnecessary and many varieties of

(*Concluded on page* 206.)

The quality, reliability and service of

BLYTHE

COLOURS, ENAMELS & MATERIALS



are appreciated!

Founded 1870.

•YOU ARE SAFE IN DEALING WITH BLYTHE

Look at the way in which Blythe Sales have gone up in the last ten years! We have always said that Blythe quality, reliability and service are appreciated—it is gratifying to find that Blythe customers uphold our contentions in such unmistakable manner.

We have put up a lot of new plant and can handle output even more promptly than before—you are safe in dealing with Blythe—you get the right article at the right price.

BLYTHE COLOUR WORKS LTD.

CRESSWELL, STOKE-ON-TRENT.

The Week's News in Brief

Trade Talk

EXTENSIONS ARE TO BE MADE to the Stanton Ironworks in the near future.

FURTHER EXTENSIONS are to be made to the Newark works of the Ransome & Marles Bearing Company, Limited.

A PLAN TO AMALGAMATE trade unions in the engineering industry will be discussed at a private conference to be held in York next week.

IT IS PROPOSED to increase the capital of Lancashire Dynamo & Crypto, Limited, to £460,000 by the creation of 80,000 £1 ordinary shares.

T. FEARNLEY ALLEN & SON have changed their address to 42, Upper Dean Street, Birmingham, 5. Their new telephone number is Midland 1902.

MITCHELL, RUSSELL & COMPANY, LIMITED, Chattan Foundry, Bonnybridge, held their annual staff social last week. Mr. T. B. Preston, secretary of the company, presided.

J. L. THOMPSON & SONS, LIMITED, are to build an 8,000-ton cargo and passenger vessel for the Barry Shipping Company, Limited, of Cardiff. It is to be fitted with White's engines.

THE FOUNDRY attached to the Southern Railway's marine factory, Snargate Street, Dover, was completely buried by a cliff fall on Sunday. Adjoining workshops were also damaged.

THE TREASURY has announced that the 33⅓ per cent. duty on imported pig-iron will be abolished and that the duty on iron and steel products imported with a quota certificate and a certificate of origin will be reduced from 20 to 10 per cent.

A BRONZE COAT-OF-ARMS of the Caledonian Insurance Company, Edinburgh, has been modelled and cast at the works of Charles Henshaw, Edinburgh, for the pediment over the portico of the company's new buildings in Hartford, Connecticut, U.S.A.

A LECTURE WAS GIVEN recently by Mr. T. R. Walker, chief research chemist of the English Steel Corporation, on "Testing and Control of Foundry Sands," to members of the Refractories Association of Great Britain, at the Royal Hotel, Sheffield.

AN ORDER for a 5,150-ton cargo and passenger ship has been received by Swan, Hunter & Wigham Richardson, Limited, Wallsend, from the British India Steam Navigation Company, Limited, London. The vessel will be fitted with Diesel engines by Swan Hunter's.

THE FURNESS SHIPBUILDING COMPANY, LIMITED, Haverton Hill-on-Tees, have received an order from the United Africa Company, Limited, for a steamer of 8,000 tons. The engines will be built by the North-Eastern Marine Engineering Company, Limited, of Wallsend.

THE INAUGURAL MEETING of the Ebbw Vale Metallurgical Society, was held on Saturday, February 20. Mr. A. S. Huxley, general manager of Richard Thomas & Company's sheet works in South Wales, presided. A Paper was read by Mr. Walter Lewis, of Ebbw Vale, on "The Basic-Bessemer Process."

Elements of Costing with Reference to Vitreous Enamelling

(*Concluded from page* 198.)

What enamellers are interested in, however, are divisible profits, and the Companies Act gives no assistance as to the meaning of the term "profit," nor are there settled principles upon which profit may be determined. Jessel, Master of the Rolls, in the course of his judgment in Dent *v.* London Tramways Company, 1879, defined profits for the year as "the surplus in receipts after paying expenses and restoring the capital to the position it was in at the commencement of the year." It will be seen, therefore, that any periodical profit and loss account is in the nature of an estimate, the accuracy of which will depend entirely on the competence of the person or persons drawing up the statement. The most reliable method of calculating profit would be to have an expert valuation of the liabilities and assets at the close of each financial period. Then the excess of assets over liabilities would be compared with the excess of assets over liabilities at the commencement of the period, after making adjustment for any new capital or capital withdrawn during the period under review, the difference representing the true profit or loss of the business for the period in question. The valuation would be on the basis of the company as a going concern and not on the break-up value of the items.

As this Paper is called "The Elements of Costing," the author has refrained from elaborating methods of analysing wages, materials and expenses, works routine and the statistical presentation of results, each one of which is worthy of a Paper of its own.

Company Reports

Clarke, Chapman & Company, Limited.—Dividend on the ordinary shares of 8 per cent.

John Brown & Company, Limited.—Interim dividend of 5 per cent., tax free, on the 10s. ordinary shares.

Scottish Iron & Steel Company, Limited.—Final dividend on the ordinary shares of 6 per cent., making 8 per cent. for the year.

Lancashire Steel Corporation, Limited.—Final dividend on the ordinary shares of 3½ per cent., making 5 per cent. for the year ended December 31 last.

National Gas & Oil Engine Company, Limited.—Dividends of 5 per cent. on the preference shares for the year 1936 and 2 per cent., less tax, on the ordinary shares.

Vickers, Limited.—Final dividends of 2½ per cent. less tax, on the preferred 5 per cent. stock, 2½ per cent., less tax, on the 5 per cent. preference stock, and 2½ per cent., free of tax, on the cumulative preference stock.

James Booth & Company (1915), Limited.—Net profit, after tax, for 1936, £89,946; brought in, £25,420; preference dividend, £8,540; dividend on the ordinary shares for the year of 15 per cent., £34,312; to reserve, £30,000; staff fund, £5,000; carried forward, £37,514. Meeting, March 11.

Contracts Open

Glyncorrwg, March 6.—Cast-iron pipes and special castings, for the Urban District Council. The Engineer, Council Offices, Cymmer, Port Talbot.

Preston, March 8.—Iron special castings, for the Waterworks Department. The Water Engineer, Municipal Building, Preston.

Pretoria, April 9.—1,500 cast-iron spigot and socket pipes (3¼ in. by 9 ft.), for the Union Tender and Supplies Board. The Department of Overseas Trade. (Reference T 31,185.)

Rotherham, March 8.—1,968 yds. of 6-in. dia. cast-iron spigot and socket pipes in 12-ft. lengths, and special castings, for the Rural District Council. Mr. A. E. Lant, engineer, Council Offices, Grove Road, Moorgate, Rotherham. (Fee £2 2s., returnable.)

Skipton.—Ironwork and machinery, for the Rural District Council. Mr. A. Rodwell, engineer, Rural District Council Offices, Skipton.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Wombwell Foundry & Engineering Company, Limited.—Capital, £100. Subscriber: O. J. Hook, "Dorana," Grange Crescent, Chigwell.

Stokes, Taylor & Shaw, Limited, Hamilton Road, Sutton-in-Ashfield, Notts. — Capital, £30,000. Founders, steel manufacturers and fabricators.

Purdy's (Manchester), Limited, 17, Albert Street, Manchester.—Capital, £2,000 in £1 shares. Brass, bronze and iron founders, etc. Director: H. Wilson.

E. Holden & Company (Birmingham), Limited, 21/23, Barr Street, Hockley, Birmingham.—Capital, £2,000. Brassfounders. Directors: Eva A. Holden and R. Dawson.

Personal

VISCOUNT RIDLEY has joined the board of the Consett Iron Company, Limited.

MR. FRED FERGUSON has been appointed a representative of Carron Company in Scotland for the sale of electric cooking and heating appliances.

MR. GEORGE M. MENZIES, a director of the North British Steel Foundry, Limited, Bathgate, has been admitted a member of the Edinburgh Merchant Company.

SIR WALTER HARRY EVANS, of Joseph Evans & Sons (Wolverhampton), Limited, pump manufacturers, has been re-elected unopposed as a member of the Staffordshire County Council.

MR. J. MALBORN, of the United Engineering & Foundry Company, of Pittsburgh, has entered the services of Davy Bros., Limited, of Sheffield, in the capacity of "outside technical representative."

Obituary

MR. CHARLES SHOTTON, who was a director of Shotton Bros., Limited, ironfounders, of Oldbury, died last Saturday, aged 76.

MR. GEORGE A. HARVEY, chairman and founder of G. A. Harvey & Company (London), Limited, sheet metal workers and engineers, died on February 25, aged 84.

THE DEATH HAS OCCURRED of Mr. D. T. Rees, of Newport, who was manager of the Newport foundry of Gould's Foundries, Limited, for twenty years. He was 65 years of age.

MR. DAVID HUNTER, who died on February 20, at the age of 81, was for over 50 years in the employ of Smith & Wellstood, Limited, before retiring some years ago.

MR. JOHN JAMES LANG, a director of P. MacCallum & Sons, Limited, shipowners and iron and steel merchants, and chairman of John Hastie & Company, Limited, engineers and ironfounders, Greenock, died on February 24, aged 59.

Forthcoming Events

MARCH 9.

Institute of Metals, North-East Coast Section:—Annual General Meeting; "Large Non-Ferrous Castings," Paper by J. E. Newson, M.Met., at the Armstrong College, Newcastle-upon-Tyne, at 7.30 p.m.

MARCH 10 AND 11.

Institute of Metals:—Annual General Meeting and Annual Dinner.

MARCH 15.

Sheffield Society of Engineers and Metallurgists:—"Steel from the Standpoint of the Railway Companies," Paper by T. H. Turner, M.Sc., at Mappin Hall, St. George's Square, Sheffield.

MARCH 22.

Institute of Welding, North-Eastern Branch:—"Cast Iron Welding," Paper by L. Tibbenham, at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.30 p.m.

Institute of British Foundrymen

MARCH 6.

Lincolnshire Section:—Annual Dinner at Loughborough.

Bristol Section:—"Problems of the Non-Ferrous Foundry," Paper by F. Dunleavy, at the Merchant Venturers' Technical College, Bristol, at 7 p.m.

Lancashire Branch:—"Light Repetition Castings," Paper by R. P. Layfield, at the Engineers' Club, Albert Square, Manchester, at 4 p.m.

Falkirk Section:—"Foundry Sands," Paper by W. Y. Buchanan, at the Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

MARCH 9.

Burnley Section:—Annual General Meeting; "Cupola Practice," Paper by J. Jackson, at the Municipal College, Ormerod Road, Burnley, at 7.15 p.m.

MARCH 12.

Middlesbrough Branch:—Annual General Meeting, at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

MARCH 13.

Scottish Branch:—Annual General Meeting; "Gates and Risers" on (a) Grey Iron Castings, (b) Steel Castings, two Papers by J. Longden and A. D. Kirby, respectively, at the Royal Technical College, Glasgow, at 4 p.m.

West Riding of Yorkshire Branch:—Works visit to Peglers, Limited, Doncaster.

The Institute of Vitreous Enamellers

MARCH 12.

Southern Section:—"Vitreous Enamelling in the Soviet Union," Paper by J. H. Gray from data received from the Trust of Municipal Equipment, Moscow, at British Industries House, Marble Arch, London, W.1, at 8 p.m.

"What about it—?"

This about it. Trouble in the foundry, like the poor, is always with us.

British Virgin aluminium does, at any rate, cut out one source of trouble and gives you time to trace the others.

THE
British Aluminium
CO. LTD

HEAD OFFICE: ADELAIDE HOUSE, LONDON, E.C.4

Telephone: Mansion House 5561 & 8074 (6 lines) *Telegrams: Cryolite, Bilgate, London*

F.T.J. 4.3.37

Raw Material Markets

An agreement between the National Federation of Scrap Iron and Steel Merchants and the British Iron and Steel Federation, which stipulates that members of the former will not sell scrap for export except under special conditions, and which aims to stabilise values in every district, has been concluded and has generally been well received.

Prices of finished iron have been officially advanced £1 7s. 6d. per ton, except in the case of marked bars. That branch is still under consideration. A rise in steel prices on June 1 is almost certain.

Pig-Iron

MIDDLESBROUGH.—Local steelworks continue to absorb the output of the blast furnaces at present operating. Any surplus material is distributed as evenly as possible, but the demand outstrips the supply. Prices are unchanged and nominal, No. 3 Cleveland G.M.B. being quoted at 81s. per ton in the Middlesbrough area, 83s. elsewhere on the North-East Coast, 84s. in Falkirk, and 87s. on Clydeside.

Supplies of hematite, already scarce, will be further adversely affected by the decision to transfer one furnace which has been engaged on the production of hematite to the production of ferro-manganese. In existing circumstances export business is confined to the despatch of deliveries in fulfilment of old contracts. East Coast mixed numbers are quoted at 97s. 6d. per ton in the Middlesbrough area, 103s. in Sheffield, and 108s. 6d. in Birmingham, subject to a rebate of 5s. per ton.

LANCASHIRE.—Conditions in this area are very satisfactory, and makers are able to meet the requirements of consumers. Consumption is heavy, but it is believed that consumers are also building up stocks. For delivery in the Lancashire price zone, offers of Staffordshire and Derbyshire brands of No. 3 iron are quoted on the basis of 89s. per ton, with Northamptonshire brands at 87s. 6d. and Derbyshire forge iron at from 84s. to 86s. Prices of hematite are firm and supplies are very scarce.

MIDLANDS.—Inquiries for all descriptions of iron are on an expanding scale. Supplies of Derbyshire material are less plentiful than they were, while Northamptonshire makers are refusing new business. For delivery to Birmingham and Black Country stations, No. 3 foundry iron is quoted at 83s. 6d. for Northants and 86s. for Derbyshire, Lincolnshire or North Staffordshire iron. Hematite producers also are having to refuse new inquiries owing to the lack of supplies. Makers are willing to renew old contracts, however. For delivery to Birmingham and Black Country stations, West Coast mixed numbers are quoted at £5 9s. 6d., East Coast No. 3 at £5 8s. 6d., and Welsh mixed numbers at £5 8s.

SCOTLAND.—Difficulties in obtaining additional supplies of pig-iron are increasing in this area, and the outlook is not bright. The official minimum prices of 90s. 6d. for No. 1 and 88s. for No. 3 foundry, f.o.t. blast furnaces, are still quoted for any new business that is accepted. No. 3 Cleveland iron is at 84s. f.o.t. Falkirk and 87s. f.o.t. Glasgow, but these figures are purely nominal. Hematite mixed numbers are quoted at 98s., less 5s. rebate, and basic, British and Indian, at 82s. 6d., less 5s. rebate, delivered local steelworks.

Metal Degreasing

(*Concluded from page 202.*)

work can be operated in large quantities, this depending chiefly on the size of the plan.

(3) One has done the job better than any other means at present available.

(4) The alkaline cleaner (if one is to follow with this) will last much longer, and lower concentrations may be used.

(5) It dispenses with the use of the furnace for a purpose often interfering with general progress.

(6) Rejects due to grease are eliminated, especially is this the case where work is also operated in an alkaline cleaner. The latter also assists the removal of dirt (dry dirt) entrapped in castings or recessed work.

(7) Personal experience is that the trichlorethylene method reduces cleaning costs generally.

Coke

Business in the foundry-coke market is chiefly confined to sales to consumers who have found it necessary to add to the tonnage already contracted for, most of them being covered ahead. For delivery to Birmingham and district, best Durham coke is quoted at 42s. 6d. and upward, and Welsh coke from 40s. to 56s. per ton.

Steel

Business in the steel market has been on a restricted scale owing to the difficulty consumers find in placing fresh orders, says the official report of the London Iron and Steel Exchange. The situation is further complicated because the usual expansion in trade which takes place in the spring is beginning to make itself felt. Already most of the steelworks have orders in hand sufficient to last them for three or four months, and in many cases they are reluctant to accept new business. The position in the semi-finished steel market is becoming increasingly stringent, and consuming works are hard pressed to maintain operations. The position in this department has not improved and outputs are not sufficient to meet the demand. All the makers of this class of material are inundated with orders, but many of them are only able to accept business for unspecified delivery. The demand for finished steel appears to be increasing, but in many instances the manufacturers have the whole of their production earmarked for some time to come in satisfaction of existing contracts. It is difficult to arrange export business in these circumstances, but efforts are being made to retain old-standing connections in foreign markets.

Scrap

Details of the price control agreement between the British Iron and Steel Federation and the National Federation of Scrap Iron and Steel Merchants, reveal that no scrap will be sold for export, and prices have been stabilised on the basis of current official prices in every district of the country. Permission to export, however, in classes of scrap not regarded as essential raw material for use in this country, may be given on application to the Central Scrap Agency, established by the British Iron and Steel Federation. The agreement provides that the steelworks will confine their merchant purchases to members of the National Federation of Scrap Iron and Steel Merchants, and that members of that federation will confine their sales either to steelworks direct or to merchants who are members of the Scrap Federation.

It is reported from the Cleveland area that while it has been agreed to release all available scrap at economic prices, no decision has as yet been reached as to the exact quotations. Heavy steel scrap is now being inquired for by local steelmakers at 67s. per ton. The official prices of heavy machinery metal and ordinary heavy foundry cast iron are 75s. and 77s. 6d. respectively, but it is stated that 77s. 6d. and 80s. has been paid for these qualities. A large number of small sales has been made in the Midlands, and the aggregate tonnage involved has been substantial. Some good business has gone through on the Yorkshire market at steady prices. Pending ratification of the agreed fixed prices, business in Scotland has been quiet.

Metals

Following a few days of unusual excitement in the metal markets, conditions became quieter again, and prices of both copper and tin fell substantially. A sharp recovery took place at the end of the week and prices returned to high levels.

Copper.—The decline in prices recently is not generally regarded as an indication of any particular weakening in the market, as it was fully realised that a quotation for copper well above the £70 mark was not only abnormal, but due very substantially to the interest of speculators. The price is now well over the £70 mark again.

Daily market prices :—

Cash.—Thursday, £69 to £69 1s. 3d.; Friday, £69 8s. 9d. to £69 10s.; Monday, £66 5s. to £66 10s.; Tuesday, £68 8s. 9d. to £68 12s. 6d.; Wednesday, £70 15s. to £70 17s. 6d.

Three Months.—Thursday, £68 18s. 9d. to £69; Friday, £69 3s. 9d. to £69 5s.; Monday, £66 2s. 6d. to £66 5s.; Tuesday, £67 18s. 9d. to £68; Wednesday, £69 2s. 6d. to £69 5s.

Tin.—There has been a decided lull in activity in this market during the past week and new buying has been restricted. As a result, prices declined from their recent high levels, but became firm again at the end of the week. A feature of the market which continues to give satisfaction is the state of the tinplate industry throughout the world.

According to the monthly statistics of tin compiled by Mr. W. H. Gartsen (Henry Rogers, Sons & Company) the total visible supply at the end of February was 18,758 tons, as compared with 19,791 tons at the end of January and 14,480 tons a year ago. The carry-over in the Straits Settlements at the end of February was 2,924 tons, against 3,568 tons a month ago, while the carry-over at the Arnhem (Holland) smelter was 1,074 tons against 1,563 tons. World production of tin increased by 22.2 per cent. in 1936 to a total of 171,888 tons, against 140,652 tons in 1935, according to the International Tin Research and Development Council's bulletin, published by the Hague Statistical Office. This is the highest production since 1929, when an output of 186,986 tons was recorded.

Considerable interest attaches to Friday's meeting of the International Tin Committee, at which it is expected that quotas for the second quarter will be decided. The quota till the end of March is fixed at 100 per cent.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £248 5s. to £248 15s.; Friday, £246 15s. to £247 5s.; Monday, £242 10s. to £243; Tuesday, £244 10s. to £244 15s.; Wednesday, £250 5s. to £250 10s.

Three Months.—Thursday, £249 to £249 5s.; Friday, £247 10s. to £247 15s.; Monday, £243 to £243 10s.; Tuesday, £245 10s. to £245 15s.; Wednesday, £251 10s. to £251 15s.

Spelter.—This market is strong and prices have remained firm. Brassmakers are taking up heavy tonnages, and it is reported that supplies of high-grade metal are becoming short. Under the new Anglo-Canadian trade agreement, the existing arrangements regarding the duties on zinc are continued, and a letter accompanying the agreement provides that a duty may be imposed on Canadian zinc if necessary to maintain the production of zinc in the United Kingdom at a satisfactory level, having regard to the needs of national security.

Official quotations were as follow :—

Ordinary.—Thursday, £30; Friday, £29 16s. 3d.; Monday, £29 7s. 6d.; Tuesday, £30 7s. 6d.; Wednesday, £31 1s. 3d.

Lead.—It is not unlikely that further increases in the price of lead will be made, as demand is on a fair scale, while supplies are not plentiful. Most genuine consumers are well covered, but producers have a considerable amount of speculation to combat. The market in the United States is active, and the current quotation is 7 cents per lb. New York, having been still further advanced.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £31 12s. 6d.; Friday, £31 16s. 3d.; Monday, £31 12s. 6d.; Tuesday, £31 13s. 9d.; Wednesday, £32 8s. 9d.

WHEN THINKING OF
SANDBLAST
THINK OF
RICHARDSON'S
Established 1887.
We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.
Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.
Phone: MIDLAND 2281.
Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.

For **"easy stripping"** use

YORKSHIRE SAND

Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractoriness of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.

Please address all enquiries to the nearest Sales Office :

GENERAL REFRACTORIES LTD.,

Genefax House, Sheffield

Telephone : *Sheffield 31113 (6 lines).*

Telegrams : *"Genefax, Sheffield."*

LONDON OFFICE:	SCOTTISH OFFICE:	SOUTH WALES OFFICE:	MANCHESTER OFFICE:
Russell House, Adelphi, W.C.2.	156, St. Vincent St., Glasgow.	11, Wind St., Swansea.	9, Albert Square, Manchester, 2.
Telephone: Temple Bar 7361.	Telephone: 5250.	Telephone: 3680.	Telephone: Blackfriars 6130.
Telegrams: "Genefax, Rand-London."	Telegrams: "Genefax, Glasgow."	Telegrams: "Genefax, Swansea."	Telegrams: "Genefax, Manchester."

★

Read what an IMPORTANT STEELFOUNDER says :—

"During the 40 years I have been connected with Steel Foundry work, considerable changes have taken place. Away back, we had Steel Moulders' Composition, Old Crucible Pots, etc., and each works claimed to have its own 'secret' moulding composition. High Silica Sand has eliminated practically all these from many foundries and to-day we have your 'Yorkshire Sand' which acts almost like a chill, and leaves the skin of the casting blue-black and as clean as cast iron.

The hot steel lies quietly against the wall of sand, and often when the casting has been lifted out of the mould, the latter looks as if it could be used over again, just like a permanent mould."

RAW MATERIALS—PRICE LIST

(Wednesday, March 3, 1937)

COPPER

	£ s. d.
Standard cash	70 15 0
Three months	69 2 6
Electrolytic	73 10 0
Tough	75 1 3
Best selected	75 11 3
Sheets	104 6 3
India	86 1 3
Wire bars	76 16 3
Ingot bars	76 16 3
H.C. wire rods	80 6 3
Off. av. cash, Feb.	59 5 6
Do., 3 mths., Feb.	59 6 9
Do., Sttlmnt., Feb.	59 5 3
Do., Electro, Feb.	64 11 10½
Do., B.S., Feb.	64 13 9
Do., wire bars, Feb.	65 3 6
Solid drawn tubes	15½d.
Brazed tubes	15½d.
Wire	10d.

BRASS

Solid drawn tubes	13½d.
Brazed tubes	15½d.
Rods, drawn	12d.
Rods, extd. or rlld.	6¼d.
Sheets to 10 w.g.	11½d.
Wire	11d.
Rolled metal	10¾d.
Yellow metal rods	7¾d.

TIN

	£ s. d.
Standard cash	250 5 0
Three months	251 10 0
English	250 15 0
Bars	252 5 0
Straits	252 10 0
Australian	—
Eastern	253 7 6
Banca	253 7 6
Off. av. cash, Feb.	233 19 7½
Do., 3 mths., Feb.	234 16 8½
Do., Sttlmt., Feb.	233 19 6

SPELTER

	£ s. d.
Ordinary	31 1 3
Remelted	29 5 0
Hard	27 5 0
Electro 99.9	33 15 0
English	32 2 6
India	27 0 0
Zinc dust	30 0 0
Zinc ashes	10 5 0
Off. aver., Feb.	25 4 5½
Aver. spot, Feb.	25 2 5½

LEAD

	£ s. d.
Soft foreign ppt.	32 8 9
Empire (nom.)	32 8 9
English	34 10 0
Off. aver., Feb.	28 6 2½
Aver. spot, Feb.	28 6 4½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	42 10 0 to 43 0 0
Do., V.M. ex-whse.	42 10 0 to 43 0 0
Rods	42 10 0

ANTIMONY

	£ s. d.
English	82 0 0 to 83 0 0
Chinese, ex-whse.	73 10 0
Crude, c.i.f. (nom.)	38 0 0

QUICKSILVER

	£ s. d.
Quicksilver	14 9 6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£ 2 6
45/50%	10 15 0 to 12 0 0
75%	15 15 0 to 17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	3/9 lb.
Tungsten metal powder—	
98/99%	3/10½ lb.
Ferro-chrome—	
2/4% car.	31 17 6
4/6% car.	21 10 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	32 10 0
Max. 1% car.	35 15 0
Max. 0.5% car.	36 10 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	7/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£13 15 0 to 14 5 0
76/80% packed	£14 15 0 to 15 5 0
76/80% export	£13 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel		3 10 0
Mixed iron and steel	3 5 0	to 3 7 6
Heavy cast iron		3 10 0
Good machinery	4 2 6	to 4 5 0
Cleveland—		
Heavy steel		3 7 0
Steel turnings		2 5 0
Heavy cast iron	3 15 0	to 3 17 6
Heavy machinery	3 17 6	to 4 0 0
Midlands—		
Short heavy steel	3 10 0	to 3 12 6
Light cast-iron scrap	2 17 6	to 3 0 0
Heavy wrought iron	3 10 0	to 3 17 6
Steel turnings	2 2 6	to 2 5 0
Scotland—		
Heavy steel	3 5 0	to 3 7 0
Ordinary cast iron	3 15 0	to 3 16 6
Engineers' turnings		2 7 6
Cast-iron borings		2 2 6
Wrot-iron piling		4 0 0
Heavy machinery	4 2 6	to 4 5 0

London—Merchants' buying prices, delivered yard.

Copper (clean)	58 0 0
Brass	34 0 0
Lead (less usual draft)	26 10 0
Tea lead	22 0 0
Zinc	18 0 0
New aluminium cuttings	74 0 0
Braziery copper	53 0 0
Gunmetal	54 0 0
Hollow pewter	175 0 0
Shaped black pewter	127 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	83/6
,, No. 3	81/-
,, No. 4	80/-
Forge No. 4	80/-
Hematite No. 1	98/-*
Hematite M/Nos.	97/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	98/-*
,, d/d Birm.	109/6*
Malleable iron d/d Birm.	135/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	83/-
,, No. 3 fdry.	86/-
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/-
,, fdry. No. 3	86/-
,, fdry. No. 1	89/-
Scotland—	
Foundry, No. 1, f.o.t.	90/6
,, No. 3, f.o.t.	88/-
Cleveland No. 3, Glasgow	87/-
,, ,, Falkirk	84/-
Scottish hem. M/Nos. d/d	98/-*
Sheffield (d/d district)—	
Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	103/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	89/-
Staffs fdry. No. 3	89/-
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/-
Glengarnock, No. 3	105/-
Clyde, No. 3	105/-
Monkland, No. 3	105/-
Summerlee, No. 3	105/-
Eglinton, No. 3	105/-
Gartsherrie, No. 3	105/-
Shotts, No. 3	105/-

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)		11 17 6
Nut and bolt iron	10 5 0	to 10 15 0
Hoops	12 15 0	and up.
Marked bars (Staffs) f.o.t.		13 0 0
Gas strip	12 15 0	and up.
Bolts and nuts, ¾ in. × 4 in.		17 17 6 and up.
Steel—		
Plates, ship, etc.	9 10 6	to 9 13 0
Boiler plts	10 0 6	to 10 3 0
Chequer plts.		11 3 0
Angles		9 3 0
Tees		10 3 0
Joists		9 3 0
Rounds and squares, 3 in. to 5½ in.		10 3 0
Rounds under 3 in. to ⅜ in. (Untested)		9 10 0
Flats—8 in. wide and over		9 8 0
,, under 8 in. and over 5 in.		9 13 0
Rails, heavy	8 5 0	to 8 10 0
Fishplates		12 10 0
Hoops (Staffs)		10 5 0
Black sheets, 24g. (4-t. lots)		12 0 0
Galv. cor. shts. (,,)		14 0 0
Galv. flat shts. (,,)		14 10 0
Galv. fencing wire, 8g. plain		16 0 0
Billets, soft		6 5 0
Sheet bars	6 2 6	to 6 10 0
Tin bars	6 2 6	to 6 10 0

PHOSPHOR BRONZE

	Per lb. basis
Strip	14½d.
Sheet to 10 w.g.	15½d.
Wire	16½d.
Rods	16½d.
Tubes	19¾d.
Castings	15½d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	22.76
No. 2 foundry, Valley	21.00
No. 2 foundry, Birm.	17.38
Basic, Valley	20.50
Malleable, Valley	21.00
Grey forge, Valley	20.50
Ferro-mang. 80%, seaboard	80.00
O.-h. rails, h'y, at mill	39.00
Billets	34.00
Sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Chicago	2.15
Steel bars	2.20
Tank plates	2.05
Beams, etc.	1.90
Skelp, grooved steel	1.80
Steel hoops	1.95
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.40
Wire nails	2.25
Plain wire	2.60
Barbed wire, galv.	2.75
Tinplates, 100-lb box	$4.85

COKE (at ovens)

Welsh foundry	32/- to 33/-
,, furnace	27/- to 28/-
Durham foundry	25/6 to 26/6
,, furnace	23/-
Scotland foundry	28/-
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	19/9 to 21/-
,, 28×20 ,,	39/6 to 42/-
,, 20×10 ,,	28/3
,, 18¾×14 ,,	20/9
C.W. 20×14 ,,	17/- to 17/3
,, 28×20 ,,	35/6 to 35/9
,, 20×10 ,,	24/-
,, 18⅜×14 ,,	17/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£8 10 0 to £9 10 0
Bars-hammered, basis	£17 0 0 to £18 0 0
Bars and nail-rods, rolled, basis	£17 0 0 to £18 0 0
Blooms	£13 0 0 to £14 0 0
Keg steel	£26 0 0 to £29 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'd	£13 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 9.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.		
Feb.	25	..	69	0	0	inc.	42/6
,,	26	..	69	8	9	,,	8/9
Mar.	1	..	66	5	0	dec.	63 9
,,	2	..	68	8	9	inc.	43/9
,,	3	..	70	15	0	,,	46/3

Electrolytic Copper

			£	s.	d.		
Feb.	25	..	74	0	0	inc.	50/-
,,	26	..	74	0	0	No	change
Mar.	1	..	70	0	0	dec.	80/-
,,	2	..	72	10	0	inc.	50/-
,,	3	..	73	10	0	,,	20/-

Standard Tin (cash)

			£	s.	d.		
Feb.	25	..	248	5	0	inc.	155/-
,,	26	..	246	15	0	dec.	30/-
Mar.	1	..	242	10	0	,,	85/-
,,	2	..	244	10	0	inc.	40/-
,,	3	..	250	5	0	,,	115/-

Tin (English ingots)

			£	s.	d.		
Feb.	25	..	248	5	0	inc.	115/-
,,	26	..	247	0	0	dec.	25/-
Mar.	1	..	242	10	0	,,	90/-
,,	2	..	244	10	0	inc.	40/-
,,	3	..	250	15	0	,,	125/-

Spelter (ordinary)

			£	s.	d.		
Feb.	25	..	30	0	0	inc.	6/3
,,	26	..	29	16	3	dec.	3/9
Mar.	1	..	29	7	6	,,	8/9
,,	2	..	30	7	6	inc.	20/-
,,	3	..	31	1	3	,,	13/9

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
Feb.	25	..	32	11	3	inc.	8/9
,,	26	..	32	7	6	dec.	3/9
Mar.	1	..	32	1	3	,,	6/3
,,	2	..	33	1	3	inc.	20/-
,,	3	..	33	15	0	,,	13/9

Lead (soft foreign, prompt)

			£	s.	d.		
Feb.	25	..	31	12	6	inc.	22/6
,,	26	..	31	16	3	,,	3/9
Mar.	1	..	31	12	6	dec.	3/9
,,	2	..	31	13	9	inc.	1/3
,,	3	..	32	8	9	,,	15/-

Lead (English)

			£	s.	d.		
Feb.	25	..	33	10	0	inc.	20/-
,,	26	..	33	15	0	,,	5/-
Mar.	1	..	33	15	0	No	change
,,	2	..	33	15	0	,,	,,
,,	3	..	34	10	0	inc.	15/-

AVERAGE PRICES OF GALVANISED CORRUGATED SHEETS (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1906	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 12 6	12 12 6	12 15 0	12 15 0	12 15 0	13 5 0	12 12 11½
1907	13 5 0	13 5 0	13 15 0	13 15 0	13 15 0	13 15 0	13 17 6	13 17 6	13 17 6	13 2 6	13 2 6	13 2 6	13 10 10
1908	13 2 6	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 11 0½
1909	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 16 8
1910	11 15 0	12 5 0	12 5 0	11 15 0	11 10 0	11 10 0	11 12 6	11 12 6	11 12 6	11 12 6	11 10 0	11 10 0	11 13 4
1911	11 5 0	11 1 3	10 15 0	10 15 0	10 13 9	10 10 0	10 13 9	11 0 0	11 5 0	11 5 0	11 5 0	11 7 0	10 19 7½
1912	11 10 0	11 10 0	11 10 0	11 15 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 12 6	12 18 0	12 15 0	12 2 11½
1913	12 15 0	12 15 0	12 15 0	12 11 3	11 18 0	11 15 0	11 15 0	11 15 0	11 15 0	11 3 0	11 0 0	11 2 6	11 18 4
1914	11 7 0	11 7 6	11 7 6	11 5 7½	11 2 6	10 15 0	10 15 0	12 17 6	14 2 0	13 7 0	11 15 7	11 2 6	11 16 0
1915	11 10 8½	13 12 6	14 8 9	15 0 6	17 17 6	20 17 6	20 17 6	20 6 3	17 12 6	18 1 0	22 13 9	25 2 0	18 3 4½
1916	26 5 0	27 12 6	28 0 0	28 5 0	29 0 0	29 0 0	28 15 0	28 3 0	28 15 0	28 15 0	28 15 0	28 15 0	28 6 8½
1917	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 0 0	28 0 0	28 0 0	28 11 3
1918	28 5 0	28 15 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	28 13 4
1919	29 0 0	29 0 0	29 0 0	28 0 0	28 10 0	27 7 6	27 5 0	29 3 0	32 0 0	33 0 0	36 10 0	40 8 4	31 5 3½
1920	46 10 0	49 15 0	53 15 0	56 0 0	55 10 0	54 10 0	52 10 0	48 10 0	44 3 4	39 2 6	35 17 6	30 8 0	47 4 3
1921	28 10 0	25 17 6	24 5 0	23 3 4	22 0 0	22 0 0	23 10 0	21 12 6	20 0 0	18 15 0	18 3 9	17 2 0	22 1 7
1922	16 17 6	15 13 9	16 3 0	16 10 0	16 4 4½	15 15 6	15 16 3	16 16 0	16 8 9	16 6 3	17 1 0	17 7 6	16 7 5½
1923	18 3 1½	19 1 11½	19 8 0	19 10 0	19 7 0	19 1 3	18 0 0	18 13 1½	19 0 0	19 3 9	19 2 6	18 19 4½	18 19 2
1924	18 13 6	18 9 4½	18 5 0	17 15 11½	17 3 0	17 19 4½	18 7 6	18 8 1½	18 8 1½	17 19 6	17 11 3	17 10 0	18 0 10½
1925	17 8 6	17 1 6½	16 9 4½	16 12 0	16 9 8½	16 9 4½	16 0 6	16 1 10½	16 5 0	16 7 0	16 12 6	6 15 0	16 11 0½
1926	16 14 4½	16 5 7½	16 0 6	15 11 10½	15 11 3	16 0 0	16 16 0	16 18 9	16 14 0	16 18 9	17 10 0	6 19 0	16 10 0½
1927	16 3 1	15 7 6	15 3 3	15 3 1½	14 14 4½	14 11 6	14 1 10½	14 0 0	13 19 6	13 16 10½	13 13 1½	13 3 9	14 9 10
1928	13 0 0½	13 2 6	13 6 0	13 2 6	13 3 0	13 6 9	13 11 3	13 10 0	13 10 7½	13 12 6	13 11 6	13 10 0	13 8 8½
1929	13 11 0	13 13 1½	13 12 9½	13 10 11½	13 9 3	13 8 9	13 11 6	13 7 6	13 7 6	13 5 6	12 18 9	12 12 9½	13 7 5½
1930	12 5 0	11 15 0	11 19 6	11 18 7	11 18 0	11 17 6	11 17 6	11 17 6	11 16 3	11 12 6	11 8 9	11 5 0	11 15 11½
1931	11 4 0	11 0 0	11 0 0	11 0 0	10 13 9	9 18 9	9 13 0	9 5 3½	8 19 0½	9 16 0	9 8 9	9 4 0½	10 1 10½
1932	9 2 9	9 14 4½	9 16 0	9 13 9	9 12 6	9 12 6	9 11 0	9 4 4½	9 11 3	10 12 6	11 5 0	11 7 0	9 18 7
1933	11 15 0	11 15 0	11 15 0	11 15 0	11 17 6	12 4 0	12 10 0	12 10 0	12 12 6	12 15 0	12 15 0	12 15 0	12 4 11
1934	12 15 0	12 15 0	12 15 0	12 17 6	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	12 18 8½
1935	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 2 6	13 5 0	13 7 6	13 1 3
1936	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 14 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	13 14 5

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

LIMPET

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND

FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

AMBITIOUS Steel Foundry Metallurgist (27) with University degree and sound practical training desires position as Manager or Assistant Manager of large modern steel foundry (home or abroad). Experience includes four years' steel foundry apprenticeship and practical knowledge gained while holding positions as estimator, rate-fixer, progress engineer, shop foreman, time-study and efficiency engineer and assistant foundry manager; thoroughly versed in modern methods of costing.—Box 254, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN or Assistant desires change. Young, keen and energetic. Experienced jobbing, repetition, high-duty and ordinary cast irons. Guaranteed to get results.—Box 236, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman desires change. Wide experience in modern production methods; sound metallurgical knowledge of both ferrous and non-ferrous metals. Age 36.—Box 266, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT Chemist with metallurgical knowledge required for foundry manufacturing special and alloy irons. Write stating age, salary required, and previous experience, to: Box 268, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

DRAUGHTSMAN required, experienced in the design of structure, plant and equipment for the manufacture of vertically cast iron gas and water pipes. Applications will only be considered from men experienced in the class of work referred to, and should give full detail of past and present employment, age, and salary required.—Address: "PIPES," HEAD, WRIGHTSON & Co., LTD., Teesdale Iron Works, Thornaby-on-Tees.

FIRST-CLASS Brass Moulders, Croydon district. Full details, age, experience.—Box 264, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN required for roll foundry. Must have practical knowledge of moulding of chilled and grain rolls of all sizes, and good organising ability. In strict confidence write stating age, experience, and salary required, to: Box 252, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman required, Wolverhampton district. Must be practical man conversant with bath making and general casting work. Good prospects for competent man. Apply stating age and salary required to: Box 258, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager, experienced in loam, dry sand and green sand, required for foundry in Clyde district. A thorough grasp of modern foundry practice is essential, as successful applicant will be required to undertake a complete reorganisation and take charge of production. Good prospects for energetic man with initiative. Applications stating age, qualifications, and full particulars of experience, should be sent to: Box 270, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager required (Manchester Area). Experienced in all classes of malleable castings. Applications must state age, experience, salary required.—Box 246, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SITUATIONS VACANT AND WANTED.—*Contd*

FOUNDRY Manager required, South-West England; must be conversant with latest practice connected with plate and machine moulding of stove castings for vitreous-enamel finishing; sand and metal control, coremaking. Only thoroughly competent men need apply.—Box 234, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVE for foundry blackings, etc., with good connection. Others need not reply. Would consider partnership with suitable person.—Box 260, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REQUIRED.—Representative with first-hand connection with steel and iron founders, to sell established moulding sand in the Tyne and Tees areas. Good remuneration for first-class man.—Box 272, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FULL-TIME Travellers wanted in (*a*) Lancashire and Yorkshire; (*b*) Birmingham district; (*c*) London and Eastern Counties; for all foundry materials. Applicants must have had previous experience.—Box 256, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED for a steel foundry on the North-East Coast, a Weight Estimating Draughtsman and two Juniors. Apply stating age, experience, and salary required, to: Box 248, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED for India, a thoroughly qualified Foundry Foreman. Young single man preferred. Applicants should send full details experience to F. HARWOOD, 1/2, Gt. Winchester Street, London, E.C.2.

WANTED.—Foundry Foreman to manage general engineering foundry making all classes of loam, dry and green sand castings. Output 150 tons per week. Write stating age and experience to: Box 262, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

Tilghman Sandblast Barrel Plants; barrel sizes—60 in. x 40 in.; 36 in. x 20 in.; 20 in. x 30 in.

Tilghman Sandblast Cabinet Plants; 4 ft. 6 in. and 3 ft. 6 in. square (one for high pressure 70 lbs. per sq. in.); also small Cabinet 30 in. dia.

All complete with Air Compressors, etc.

Gas and Air Mixer by Sharpe & Preston, 2-in. outlet.

Six Osborne Pneumatic Jolt Press Moulding Machines, size 75J.

Three Mumford Yoke Headpress Pneumatic Moulding Machines.

Two Herbert Whizzer Sand Disintegrators.

Two Brealey Type ditto.

Heavy Double-ended Grinding Machines by Rowlands, Luke & Spencer, etc.

Hand Moulding Machines by Adaptable Darling & Sellars, Pridmore, Samuelson, etc.

500 Electric Motors, Dynamos, Rotary Converters, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.

'Phone: Broadwell 1359.

MACHINERY—*Continued*

TABOR Pneumatic Moulding Machines for sale. For price and particulars apply:
WILCOX & CO. (B'HAM), LTD.,
65-71, BARR STREET,
BIRMINGHAM, 19.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & Co., LTD., Station Works, Ecclesfield, Sheffield.

WANTED.—Roote's or Thwaite's Blower, approx. 3,000 c.f.m., with 12-in. bottom outlet. Full particulars to: Box 244, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

'Phone **98** Staines.

COCHRAN Boiler, 10 ft. 3 in. by 4 ft. 9 in., 100 lbs. w.p.

Air Receiver, 18 ft. 6 in. by 4 ft. 6 in., ⅝-in. plate, welded.

Harrison Carter Double-Action Mixer, 4 ft. by 3 ft. by 2 ft.

Horizontal Air Compressor, 200 c.f. at 100 lbs.

HARRY H. GARDAM & CO., LTD.,
STAINES.

THOS. W. WARD LTD.

Pneumatic 12" cyl. (Jackman) PLAIN JOLT-RAM MOULDING MACHINE; table 5' square.

Pneumatic No. 6 Ajax JOLT-RAM ROLL-OVER MOULDING MACHINE; take 36" x 24" boxes.

VERT. COCHRAN BOILER; 16' 6" x 8'; 100 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MISCELLANEOUS

SAND.—Hill and Sea Sand delivered by road or rail at your works. Write for prices.—THOMAS BALL & SONS, C.L.C. Goods Station, Southport.

OUR CORE GUM and "Binderite" Sand-binder acknowledged to be the best obtainable. Write for samples and carriage paid terms.—WILLIAM OLSEN, LTD., Hull.

GENUINE Southport Wind Blown Sand, which makes best oil-sand cores. Prompt deliveries by road into works.

JOHN LIVESEY,
SAND MERCHANT,
SOUTHPORT.

'Phone: 287 SLOUGH

SEVERAL Good Foundry Grinders, Price, **£5 to £20.**

12' square Sand Blast Room Plant complete and in good condition. Price, **£180.**

Four Morgan Oil-fired Tilting Furnaces reconditioned — 450-lbs. capacity. Also 250-lbs. and 600-lbs. capacity in stock. CHEAP.

Large stock of Moulding Machines, Compressors and A.C. Motors.

PLEASE SEND US YOUR ENQUIRIES.

ALEX. HAMMOND, *Foundry Machinery Merchant.*
14, AUSTRALIA ROAD, SLOUGH
BUY FROM ME AND SAVE MONEY!